A HANDBOOK FOR ATHLETES

THE SCIENCE AND ART OF TRAINING

DR. H. HOOLE.

TRÜBNER & CO

THE SCIENCE AND ART OF TRAINING.

Ernest Hart Esq

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SCIENCE AND ART OF TRAINING:

A HANDBOOK FOR ATHLETES.

BY

HENRY HOOLE, M.D. (Lond.)

Medical Officer to the Stock Exchange Clerks' Provident Fund.

"Health is the vital principle of bliss,
And exercise of health."

Thomson.

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THIS LITTLE WORK

IS DEDICATED AS A MARK OF RESPECT TO

MY FRIEND AND TEACHER,

JAMES CANTLIE, M.A., M.B., F.R.C.S.

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PREFACE.

My attention was first directed to the preparation required for athletic sports by enquiries from patients who were engaged in such pastimes. To supplement what knowledge I possessed upon this subject I sought for a standard authority, but there was none to be found. Information as to the training of athletes was scattered broadcast in all forms of literature—articles in scientific journals; paragraphs in medical and surgical text-books; contributions to medical papers and to works on public health; hints in lectures on sanitation; statistical records; and experiences of old athletes communicated to the sporting magazines of the day. A few, principally teachers of the Art, had attempted to collect and systematize this information; their want of scientific accuracy and their ignorance of even the elementary facts of physiology and anatomy were insurmountable barriers, and in nearly every case the results of their labour were meagre, valueless and misleading. I determined, therefore, to utilize my acquired lore by producing a small work which, to some extent, would meet an urgent demand. It has been written for the general reader and not for the student of science, and this fact must be a sufficient apology for the free use made of non-technical language.

I take, with pleasure, this opportunity of thanking my friends, Mr. J. F. D. Maillard and Dr. Robert Jones, for their kindness in supervising the book for the press; and also others in the athletic world for the valuable help they have rendered me.

HENRY HOOLE.

10, Throgmorton Avenue, E.C.

INTRODUCTION.

From remote times whenever races of men contemplated peaceful or warlike expeditions, which of necessity would involve much exertion, and test severely the powers of endurance, they carefully prepared their bodies for such feats by preliminary exercises, and by the substitution for their ordinary food of a more carefully selected diet. Antiquity of Training.

Again, when certain classes or individuals among them adopted by choice or by compulsion the occupation of soldier, performer in the arena, or competitor in the public games, greater attention was bestowed upon the development of the muscular system, and thus, in the hands of specially selected instructors, arose the "Art of Training."

Of these by-gone nations, the Greeks excelled the most in athleticism, and undoubtedly did much to create this art. Their mode of preparation was briefly as follows :—An officer, appointed by the state, fixed the diet, and previous to the exercises in the gymnasium anointed the athlete's body. No appeal could be made against the diet scale, which, both ample and varied, included amongst other articles, beef, pork, goat's flesh, cheese, boiled grain, wheaten bread, dried figs, a thick sweet wine, and water. Of all the dried fruits figs were thought—and rightly so—to be the most nourishing and sustaining. Mode adopted by the Greeks.

A restriction was imposed upon the consumption of wine and water, but the amount of solid food, or sleep, was left to

the discretion of the athlete: a laxity of discipline which made apoplexy by no means a rare disease among this class of men.

The course of training commenced with the administration of an emetic—a custom which appears to have been handed down to very recent years. The first meal of the day was a light one, consisting mainly of barley or wheaten bread, meat being reserved for a later hour. In a building fitted expressly for such sports, and known as the palæstra, the prescribed exercises were practised, and appropriate means used for the development of certain sets of muscles; the boxer* sought to increase the size of his arms and chest by striking sacks of meal suspended in the air, or by the use of the spade, while others strove to promote their strength by carrying heavy weights and by bending rods of iron.

Patience and endurance were also inculcated, and the athlete was inured to pain by being flogged on the back, until the blood flowed, with branches of a species of rhododendron.

The preparation could be commenced at an early age, as contests in the public games were arranged for youths, and the unsuccessful competitor was allowed to continue his efforts for distinction until he had reached his thirty-fifth year.

Athleticism with the Romans.

Like the Greeks, the Romans did not overlook the importance of physical education, for they defined an ignorant man as "one who knew neither how to read nor swim," but they never imbibed the same love of athleticism: the proud patricians, with few exceptions, regarding such pursuits as an occupation or recreation fit only for slaves.

Their military character and experience, however, taught them that a probation stage was necessary before their youths

* The pugilist of the last century adopted this method of training, and digging the ground is largely practised by modern athletes.

were enrolled in the army, and the four months preceding the entrance into the ranks were devoted to exercises, which tested the vigour, activity and endurance, as well as the courage and mental capacity of the recruit. Evidently they were well aware of the beneficial effects of a pure atmosphere upon physical development, for they selected as sites for the principal training schools Capua and Ravenna, and had all the sports carried on in the open air.

THE

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CHAPTER I.

THE PREPARATION FOR ATHLETICISM.

Object of Training.

The principles of training differ but slightly from those of judicious living.

Both require the same close study and proper interpretation of the laws of health, and such an application of them as will produce temperate habits and a high degree of mental and bodily vigour.

In the preparation of athletes the trainer, however, has to pay more attention to those conditions which promote, and those agents which sustain, a vigorous performance of the functions of respiration and circulation, and favour increased growth and power of the muscles.

The physical development and social surroundings of the individual are the most important of these conditions; and the agents which beyond all others materially influence his constitution are diet, exercise, rest, baths, clothing and climate.

General effects of Training.

The beneficial effects of the preparation, however careful it may be, are not at first apparent; indeed, for a few days the panting breathing, the throbbing heart and vessels, and the oppressive feeling of suffocation, indicate clearly how much the unusual muscular exertions disturb the action of the heart and lungs.

Day by day, however, the serious strain upon these organs is greatly diminished, for the blood vessels accommodate their calibre to the increased action of the heart, and soon a complete concord is established between the contractions of the muscles and the functions of respiration and circulation.

Although systematic and regular exercise is the prime factor in bringing about such a concord, this power of accommodation varies to a great extent in individuals. Those who possess it in a marked degree are easier to train, suffer the least with the distressing symptoms mentioned above, and are better fitted to encounter the terrible struggles of a closely-contested race.

Having surmounted this initial trouble, the athlete speedily shows the improvement wrought by exercise, good food and fresh air.

His chest expands, often to the extent of three inches in circumference, and, if new air cells are not developed, as some suppose, this expansion certainly allows fifty cubic inches more of air to enter the lungs, and permits these organs as well as the heart to act with greater freedom.

The circulation throughout the whole system becomes more effective and life-sustaining, allaying undue excitement of the nervous system, and giving to the mind clearness of perception and courage, while at the same time, by increasing the functions of the skin, kidneys and liver, it thoroughly removes from the body matters which are both useless and hurtful.

The muscles, too, become hard, elastic and prominent, give to the figure a more erect attitude, and render the step light and springy. The eyes are brighter, the hair more glossy, and the skin not only perspires with greater ease and regularity, but loses any cutaneous eruption and grows soft and smooth.

Far different are the changes in the nutrition of the body when the training has been imperfect or insufficient.

Evil results of an imperfect preparation.

The elastic step, brisk walk, and firm limbs, with the eagerness for all forms of exercise, so indicative of a sound muscular and nervous system, are gone. Work of any kind—if not a toil—is now an unpleasant duty, and any continued effort is followed by distressing palpitation of the heart, panting respiration, and throbbing of the large blood vessels.

Further signs of the loss of nerve energy and the absence of the healthy tone of the nervous system are revealed by the restless and dreamful sleep, the clammy skin bedewed with cold and fitful perspiration, the drawn and haggard features, the dilated pupils and eager self-conscious look, and lastly, by the drooping shoulders and listless walk.

The digestive organs share in the above derangement: meal time brings with it no appetite, and the food is often loathed ; in addition, constipation or diarrhœa adds to the athlete's manifold troubles.

Competition in Athletics.

During the last quarter of a century every form of sport has been pursued with intense ardour, and each succeeding year appears to open up a period of fiercer competition. An evil spirit of emulation has crept into the pastimes of young men, which in many cases have become less and less a recreation, and more and more an assiduous and laborious occupation.

The terrible strain thus imposed upon the constitution is only too apparent to the onlooker at our national games, and must cause the parent to doubt the possibility of a son engaging in such contests without incurring serious risk to life.

The true solution of this question is only obtained in the just estimation of any existing bodily defect of the

lad, of his social surroundings, and the influence they have had upon his physical development.

As will be seen, these are the factors which mainly operate for and against the thorough preparation for all manly sports; a preparation which ought to ensure a long and active existence, and not broken health and premature death.

Social surroundings, their effects on the physique.

Youths born and bred in large towns, and engaged early in commercial pursuits, suffer under great disadvantages. Their life is usually a sedentary one; many hours of the day are passed in dark and badly ventilated offices and warehouses, and the requirements of business shorten to within unhealthy limits the time that ought to be given to meals and exercise.

More often the latter is completely neglected, and even where recreation can be taken it is in the evening, when the nerves and muscles are exhausted by previous labour.

To make matters worse, the exercise chosen by the overworked lad is generally one involving much expenditure of force; and his muscles have in no way been prepared for the strain so suddenly put upon them.

Continuous toil, relieved once a year by a short holiday of seven to fourteen days, lessens materially the tone of the nervo-muscular system, and it should be more widely known that intermittent violent exercise is an unsuitable mode of restoring this tone. No method of training can give to the ill-developed and feeble youth of twenty either robust health, or, still more, the power of successfully and safely competing in athletic sports.

Contrast the above social surroundings with those of men the fame of whose names still lingers at Lillie Bridge, Henley and Lord's.

The majority of these athletes are the sons of landowners, of successful traders and professional men, and, guarded by the wisdom of an improved sanitary science,

have spent their early life either in the country or at the sea-side.

At the time when other lads of the same age are commencing a business career, these fortunate youths enter one of the well-known public schools, where masters—some of whom have gained notoriety on the river or in the cricket and football field—and a skilled doctor select the recreation best suited to the boy's age and physique, and keep a careful watch over his health.

A fair idea of the encouragement given to, and the position held by, athleticism in education at these schools can be formed by reading the report of a commission of French savants, who were sent to England in 1869, to enquire into the nature of the outdoor sport, and the time devoted to it by public school boys.

They ascertained that at Harrow every lad in good health was compelled during the winter to play football three times a week, while cricket in the summer absorbed 15 hours, at Winchester 18 hours, and at Eton as many as 27 in the same period of time. Moreover, at the last school no inconsiderable portion of the day was spent in swimming and rowing.

Such conditions of life naturally tend to the development of large frames, powerful muscles, and exceptional vigour, even before these lads have reached adult age. One is not surprised then to read that eight Eton boys who rowed in 1867 at Henley averaged 11 stone 9 lbs. in weight, or that four of them scaled over 12 stone.

The Universities of Oxford and Cambridge are recruited from the public schools, and the undergraduates of the above institutions furnish excellent illustrations of this marvellous vitality, and of the truth of the above statement. Last year (1887), for example, every event at the Henley regatta was won by members of the latter university.

Dr. Morgan, in his work the "University Oars," tells us that out of 294 men who had taken part in the inter-University race during a period of forty years* thirty-one (excluding accidents) alone had died, and but nine deaths were attributed, not always justly, to the severe labours of the training or of the contest. How severe the struggle was at times is best seen by glancing over the account of the races of 1886 and 1856. In the latter year the course was from Putney to Mortlake, and the day a bleak and windy one in March; at no period of the race were the boats ever clear of each other, and the verdict in favour of Cambridge was but half-a-boat's length; yet the only discomfort attending this supreme effort was that one man suffered for three weeks from muscular chills, and then completely recovered.

Dr. Morgan also relates that six men rowed four times and fourteen men three. The average annual gain in weight of the former was 2 lbs. 12 oz., and of the latter 3 lbs. 10 oz. Some of the oarsmen while in training could row 38 to 40 strokes per minute for an hour, and were able to walk 51 miles in thirteen consecutive hours without distress.

Physical defects a barrier to Training.

Nevertheless when the surroundings are so favourable as those described, a youth is often incapable of being safely prepared to meet his fellows in open competition on account of some defect or inherent weakness of his constitution which no surgical or medical skill can remedy.

The most important of these impediments to training are:—

1. Disease or predisposition to disease of one or more of the principal organs of the body, particularly of the heart, lungs and blood-vessels.

* The crew of the Cambridge boat who raced in 1840 were all living and in good health twenty-nine years after.

2. An ill-developed chest or any serious malformation of the bony framework, and a feeble muscular system. Associated with the latter is a want of vigour and usually also a lowered bodily temperature.

3. Marked disproportion between the height, weight and chest dimensions when these are compared with the recognized standards.

Dr. Inman gives three instances where early death resulted to apparently well-developed and efficiently trained men in whom existed a predisposition to consumption. One, of seemingly magnificent physique, died after fourteen days' illness; another, the stroke of his boat, became a perfect wreck in almost as short a space; while the third developed an acute form of the disease from running a race against time.

The Professional Trainer.

Such are the difficulties that a young man has to face when his thoughts tend to athleticism; and after they have been partly recognized, he, in nine cases out of ten, carries his doubts and his fears to a professional trainer.

This man usually has been a pedestrian, pugilist or sculler, and has acquired some reputation in the sport for which he trains—a reputation, it must be remembered, due not to the development of his intellect (for in education and general knowledge he is far inferior to the ordinary mechanic), but to the possession of powerful thews and sinews; and the little experience he has gained while practising his calling he ekes out with the legendary lore which has descended by word of mouth from previous generations of trainers.

I should be sorry to affirm that this class has not furnished men steady, observant and capable of forming clear and sound conclusions; but, from the very nature of their occupation and origin, it is impossible for them to record their knowledge save by spoken language,

and observations so communicated are particularly liable to be misunderstood and misapplied.

Such men are few in number. It is, as a rule, to the shallow, uneducated and often dissolute trainer that is left the solution of problems regarding the waste and repair of the human tissues and the conservation of vital energy—problems that have taxed the patient industry of a Carpenter and the wide researches of a Liebig.

Is it, then, to be wondered at, considering his blind fallacies and crude speculations, if the path of the professional trainer be strewn with the shattered constitutions of men who have so heedlessly trusted themselves to his skill?

Fallacies and theories of Trainers.

The dread of giving fluids during the preparation for all outdoor sports is an ancient prejudiee, and ean be traced back to the Greeks. Our modern trainer accepts it without compunction, and holds water in holy horror: in his own language, "Water is bad for the wind, makes the belly swell, the flesh soft, and the man sweat."

Convinced by practice that the lessened consumption of this necessary fluid, and the various modes he adopts of promoting perspiration, will decrease his pupil's weight, he does not concern himself with the question whether his method be a legitimate one or whether this unnatural drying of human flesh be detrimental to the health and to muscular force.

His next object of detestation is "fat," and his theories as to the mischief produced by this innocent tissue are only surpassed in extravagance by those respecting the influence of exercise and food in the formation of this "obnoxious substance." The system of diet and work which he follows undoubtedly removes fat from beneath the skin, and causes the muscles to appear more prominently; but this eondition is attained very often at the expense of a serious waste of nervo-muscular

energy, an impaired digestion, and grave disturbance of the action of the heart and lungs.

Equally absurd are the trainer's notions of the comparative value of different articles of food in the formation of muscle and the production of energy, and they are emphatically disproved on the day of the race by the fagged appearance of the athlete and by his complete collapse at the most critical moment of the struggle.

In conclusion, what is termed "loose flesh" is the natural condition of the muscles when insufficiently exercised, and "internal fat" exists only in the trainer's imagination.

A fuller consideration will be given in subsequent chapters to these and other fallacies, and also to the injury inflicted upon the body by the trainer's rude endeavours to substantiate his wild and improbable theories.

Principles of Training.

The principles of training will now be dealt with in detail. They are few in number, easily grasped, and can be grouped under the following headings :—

1. Preliminary examination by a medical man to ascertain soundness of constitution and physical capability to undergo severe exertion.

2. Registration at intervals of the height, weight, capacity of the chest and muscular development.

3. Apportionment of the hours of exercise, rest and meals, with the arrangement and selection of the diet.

4. Sanitation of bathing, the clothes, the bed and sitting rooms.

5. Fixation of the period of training, and at its conclusion the gradual resumption of the habits of ordinary life.

CHAPTER II.

THE FORMATION AND DEVELOPMENT OF THE HUMAN BODY.

The Skeleton.

In the description of the human skeleton one naturally commences with the "spine," a central column of small bones, perforated by a canal, and firmly united one to the other by strong tendinous bands termed "ligaments." Surmounting the spine is the "skull," the interior of which communicates with the above-mentioned canal, and within this continuous space, protected from external injury, are lodged the brain and spinal cord.

Two more or less complete osseous girdles are attached to the column, the upper one, forming the framework of the "chest," gives attachment to the bones of the arm; while the lower one, the "pelvis," assisting in the formation of the "abdomen," likewise supports those of the lower extremities.

To facilitate the movements of different parts of the frame, the surface of the bones, where they touch, are smoothed and covered with a soft elastic substance called "cartilage," the ends being bound together by ligaments, and in this way a "joint" is formed.

The chest, or "thorax," is bounded behind by the spine, in front by the breast bone, and on each side by the ribs with muscular tissue stretching between. The whole encloses a cavity, within which is contained the heart, lungs and large vessels.

The abdomen is encircled below by the pelvis, a strong, shallow, bony ring, from which and from the spine spring broad sheets of muscles; these, by passing to the

ribs and breastbone above, form the main portion of the walls of this space and give protection to the stomach, intestines, liver, kidneys, bladder and other less important organs.

From the above sketch it is seen that the human skeleton is designed to protect most from violence the brain and spinal cord, next to them the heart and lungs, and least of all the abdominal organs. And such design indicates fairly well the relative importance of these structures.

Muscles, Skin and Subcutaneous Tissue.

The muscles, besides clothing the chest and abdomen, pass along each side of the spine to the head and neck and make up nearly the whole thickness of the limbs. The structure and functions of these organs, which play so important a part in athletic exercises, deserve a fuller consideration, and will be dealt with later on at greater length. The skin acts the part of an external protecting medium, and is continuous at the orifices of the body with its more delicate modification, "the mucous membrane," which, in its turn, lines the deeper structures situated within the trunk. The ducts of two sets of minute glands perforate the skin, one secreting an oily fluid which lubricates and renders its surface soft and pliable; the other—the well-known sweat glands—fatty and saline matters dissolved in a large quantity of water, and constituting the perspiration.

By the evaporation of this water heat is lost, and, no matter what the season of the year may be, the human temperature thus regulated within narrow fluctuating limits with wonderful accuracy. Between the skin and the muscles, loosely uniting them, is a tissue called from its situation "subcutaneous," and within which, especially in later life, fat is largely deposited. This tissue fills up gaps and hollows, covers angular points, gives the rotundity to the limbs and face so characteristic

of youth, allows the muscles to glide easily beneath the skin, and, owing to its non-conducting properties, preserves the warmth of the body.

The Vital Organs and their functions.

I would gladly omit the following brief account of the nervous system, heart, lungs and other internal organs, if I were not convinced that such omission would interfere with the proper interpretation of the work.

The brain, spinal cord, and the nerves which connect them with every remote organ and tissue, compose the nervous system; its function, termed "innervation," maintains amongst other duties a just control over the brain itself, keeping the intellect, emotions and will so evenly balanced that the man is neither unduly elated nor depressed, and regulates the movements of the lungs, heart and muscles, the conversion of food into flesh and blood, the correct waste and repair, and the degree of warmth of the body. From this it may be rightly concluded that an unhealthy state of this system is attended with marked disturbance of many of the phenomena of life.

The heart and blood vessels are the organs of circulation, the first propelling and the latter distributing the blood. The vessels, roughly speaking, are of two kinds: arteries which carry blood of a bright scarlet colour, loaded with oxygen gas and nutriment (derived from the food), to whatever part of the frame these may be wanted; and veins, the contents of which, rendered impure and purple by carbonic acid gas and saline excrementitious matters, are slowly transported to the skin, lungs and kidneys for removal from the body.

The lungs, or breathing organs, by their movements during inspiration and expiration, introduce within the vessels oxygen, (which gives to the blood its scarlet appearance) and abstract the larger portion of the carbonic acid from the impure purple venous fluid.

The skin, kidneys, liver and large intestines are also principally concerned in eliminating from the body certain substances known as "waste products," consisting of fatty acids, salts, especially one containing nitrogen termed "urea," and carbonic acid gas, the retention of which products in the blood would jeopardize life.

The alimentary canal, the last of the vital organs that claims attention, is, although a continuous structure, divided into distinct parts—the mouth, throat, gullet, stomach, small and large intestines and the lower bowel.

It is designed for the preparation and absorption of food, and for the expulsion of such constituents of man's aliment as are either useless or harmful.

Connected with the canal are glands—as the salivary, the liver and the pancreas—which, like those of the stomach and intestines, secrete fluids having the property of reducing, to a more or less soluble state, the solid particles of the diet.

In the mouth, the saliva converts the starch grains into sugar; in the stomach, the gastric juice acts upon the fibres of meat and fish, forming "peptones;" and in the small intestines, the bile and pancreatic juices change the fats into a soapy emulsion. These three products of the altered food, namely, "sugar, peptones, and soapy emulsion," can now readily pass into the blood, and what remains in the large intestine may be described as a mass made up of partly dissolved and partly solid innutritious substances, the refuse and now inert digestive juices, and water. Excess of water is then absorbed, and the bulky semi-solid remainder descends into the lower bowel to be expelled, as nature dictates.

Vital Energy.

The oxygen which has gained entrance to the vessels by the channel of the lungs acts upon the products of the altered food circulating in the blood, and the result of this action is the development of vital energy.

Now vital energy manifests itself in three distinct forms—"nerve force, muscular energy and heat." The former is required for the labours of the brain and spinal cord, and for the transmission of impulses along the nerves. A modification, if not a distinct variety, of this force is "electricity," currents of which are found in the nerves themselves and in the muscles.

Muscular or mechanical energy is released in the movement of the muscles and such organs as the heart and stomach which are composed principally of muscle-fibre. No mean amount of this force, by the friction of tendons in their grooves and of bones in the joints, is converted into the third variety of energy, namely, "heat."

It has been calculated that about 30 per cent. of the whole vital energy produced is dissipated as "heat" by conduction, radiation, and evaporation from the skin; while another 6 per cent. is used up in warming the air expired by the lungs; indeed, every substance which leaves the body takes from it a considerable quantity of caloric.

When a man rests, all his vital energy, excepting what is required for the movement of the internal organs and the repair of the tissues, escapes in the form of heat; but when, however, he is occupied in mental or bodily labour, a larger proportion is discharged as nervo-muscular force.

To maintain the right production of this source of life, the individual is constantly governed by wants or appetites, of which, if existence is to be prolonged with ease and vigour, the four chief ones, namely, hunger, thirst, exercise and rest, must be adequately satisfied.

Composition and Daily Waste and Repair of the Body.

A few words respecting the composition and the daily waste and repair of the human body—for example, that of a perfectly healthy man of eleven stone—will conclude this portion of the subject.

Professor Huxley states that such a man could perform work in the twenty-four hours which would be equal to lifting 450 tons one foot high; or in scientific language, "equal to 450 foot tons." His heart should beat 75 and his lungs respire 17 times in one minute (each inspiration containing from 200 to 230 cubic inches of air), and his temperature be 98·4° Fahrenheit.

His flesh and blood are found to contain albumen, gelatin, salts of lime, soda, magnesium, iron and silicon, and all these principles should exist in his food. The muscles and fat would have the respective percentage of 41·8 and 18·2, and the component parts of his body be, according to Professor Huxley, as follows :—

Bones	24 lbs.
Muscles and tendons	68 ,,
Fat	28 ,,
Skin	10½ ,,
Internal organs	16½ ,,
Blood (drained away)	7 ,,
	154 ,,

His daily gains to replace the daily losses would be:—

Oxygen	10,000 grains.*
Water-free food	8,400 ,,
Water	36,100 ,,
	54,500 ,,

And his daily losses:—

From the	Water.	Other waste products.
Lungs	5,000 grains.	12,000 grains.†
Kidneys ...	23,000 ,,	1,000 ,,
Skin	10,000 ,,	700 ,,
Bowels... ...	2,000 ,,	800 ,,
	40,0000 ,,	14,500 ,,

* 7,000 grains equal sixteen ounces avoirdupois.

† The 12,000 grains lost from the lungs consist almost entirely of carbonic acid gas.

The Periods of Human Life.

There are four periods of life, namely, adolescence, puberty, adult age and maturity, during which changes occur that have an important bearing upon man's development, and a brief notice of these periods will not therefore be out of place.

Adolescence.

Adolescence, according to some writers, extends from the 7th to the 14th year, and at this early age a close observer can premise the future physique, and to some degree the character of the lad. Year by year the subcutaneous fat of childhood disappears, allowing the muscles to stand out more boldly, while the skin becomes less fine in texture, and the perspiration less easily excited.

Whether the youth grows up weakly and unenergetic, or vigorous and active, greatly depends on the proper distribution of the hours of play, study, leisure and sleep, as well as the arrangement of the meals; for carelessness or neglect of these matters will undoubtedly check the natural growth of the mind and body.

The meals, four in number, should be taken as follows:—Breakfast, at 8 o'clock; dinner, at 1; tea, at 5; supper, at 8: while the hour for retiring should be 9 to 10, according to the season of the year.

Friedlander's division of the 24 hours is an excellent one, and cannot be improved upon:—

Age.	Exercise or Play.	Study.	Leisure.	Sleep.
7	8 hours	2 hours	4 hours	10 hours
8	8 "	2 "	4 "	10 "
9	8 "	3 "	4 "	9 "
10	8 "	4 "	4 "	8 "
11	7 "	5 "	4 "	8 "
12	6 "	6 "	4 "	8 "
13	5 "	7 "	4 "	8 "
14	5 "	8 "	4 "	7 "

Puberty.

Puberty commences at the 14th year and ends at the 20th. It is in this period that nature, in her

own silent way, prepares the individual, not only for the struggle in the small world of sport, but also for that in the wider sphere of active life; the seal about to be set upon the body and mind is a rigid one, and man's power to alter the impression most feeble and limited. Between the ages of 14 and 16 vertical growth is extremely rapid, and produces so much exhaustion as to render the health, both at this time and for the two succeeding years, very precarious.

Nearly all the vital force available is expended on the osseous and muscular systems, and, consequently, the internal organs, more particularly the brain, show few signs of energy or of their future power. An exception to this statement must be made with regard to the digestive apparatus, for at no other time of life does it better perform its function; nevertheless, despite its great vigour, the requirements of the rapidly growing frame are insufficiently met.

Another cause which operates strongly against robust health is the slow expansion of the thorax: its annual increase of circumference is but one-and-a-half inches—a measurement quite out of proportion to the vertical growth. As would be supposed, the small and narrow chest seriously retards the development of the heart, lungs and blood vessels; and these organs, like those of digestion and assimilation, are unable to keep pace with the demands made upon them. The failure of vital functions reveals itself, especially in tall youths, by the lowered bodily temperature, the languid circulation—the hands and feet are habitually cold—the lassitude, the easy disturbance of the nervous system, and after the least exertion by the distressing palpitation and breathlessness. Towards the end of puberty the chest enlarges at a greater rate, allowing its organs to increase more quickly in size and to discharge better

their functions, but even then their activity is never commensurate with the growth of the rest of the body.

All through puberty the bones are more or less soft and pliable, and for this reason pressure upon the chest walls should be avoided, otherwise the natural inclination of the ribs will be prevented and the capacity of the thorax diminished for life.

Although as the bones consolidate the muscles mature, those of the arms and legs are always in advance of the muscles of the back and abdomen; hence lads up to the age of 18 are usually very active—good runners but poor wrestlers. From what has preceded, one may see how absurd it is for youths under 20 to attempt arduous athletic feats. Military surgeons are well aware of this immature condition, and one has placed on record his opinion that if recruits of 18 be not discharged they are doomed to spend two to four of the succeeding eight years in hospitals. Evidently, the First Napoleon was of the same mind; for he stated that his conscripts under 20 served only to strew the roadside and to fill the infirmaries. The chief precautions to be observed during this period of life are to dress warmly, to be circumspect in the use of cold baths, to avoid violent exertion, to have plenty of rest, and to be careful in the selection of the diet. The meals should be ample, contain a large percentage of animal food, with no stint of water, and be taken as in adolescence, with this exception—the supper an hour later.

Adult Age.

Development of the frame proceeds for another ten years—the period of adult age—but at a slower rate and with less demands upon the vital energy, and by 30 it is practically finished.

Although at the age of 25 the joints are completely formed and man has reached his maximum height, the bones are not yet consolidated nor the muscles matured,

and for five years more, owing to the non-solid state of the breastbone and ribs, the chest continues to expand.

This is the phase of a man's existence when there is the greatest immunity from injuries within or without the body. His nervous and muscular systems yield their utmost amount of energy; he is best fitted for the severe labours of athleticism; can endure with comparative ease, if not indeed with pleasure, privation and exposure; and possesses to a marked degree the power of adapting his constitution and habits to the varying conditions of occupation, season, and climate. He experiences now more than he has ever done before the rapture of the "wild joy of living."

A healthy man enters the period of maturity, which extends to the 45th year, with every tissue and organ in perfect functional vigour, and with a high degree of bodily and mental force. No diminution of the latter can be perceived until the age of 35. After then, year by year, a man feels a sensible decrease in his power of originating and in his power of executing: he makes less use of himself and more of others. Maturity.

A treatise on the Art and Science of Training would indeed be perfect if definite standards existed for different ages as regards health, physique, rate of growth, height, and weight. Life, however, is spent under such fluctuating conditions, and science is so progressive, that statements absolutely correct cannot be arrived at. On the other hand, approximations to the truth are not difficult to make; for the signs of health and good physique are numerous, invariable and trustworthy, and well authenticated statistics have been compiled of growth, height and weight: moreover, the whole question is much narrowed when, as in this work, the observations are restricted to the inhabitants of the British Isles, of Western Europe and of the United States. Standards.

Standard of Health.

With regard to health, a very fair standard is attained when the individual, besides exemption from hereditary taints, such as insanity, epilepsy, scrofula, gout and rheumatism, possesses the following indications of a sound constitution :—

1. All the organs well formed and performing efficiently the functions of innervation, circulation, respiration, digestion, excretion, and muscular movement.

2. A symmetrically developed body which does not deviate to any extent from the accepted standards of height and weight.

3. A marked capacity of enduring without harm the extremes of climate, exposure to severe fatigue and contagious or other diseases, and the friction of professional commercial and domestic life.

Standard of a Good Physique.

The following are the signs of a symmetrically developed body, and the man who has them, with the already mentioned indications of a healthy constitution, approaches the nearest to the highest standard of health—a sound mind in a sound body—and is fitted to compete not only in the struggles of field and flood, but also in the larger concerns of the world, and, despite his labours, will easily reach the natural term of human existence, which the best authorities have placed at 80 years.

The length of the body should be equal to the distance from the tips of the fingers when the arms and hands are fully extended at right angles to the trunk, and its middle point should fall just in front of the pubic bone. Taking the length as a standard of measurement, the face should be equal to one-tenth of it, the head to one-eighth, and the lower limbs to one-half.

The face ought to be large, its angle* not less than

* The facial angle is constructed by a line from the orifice of the ear to the nostril, intersected by another which falls from the most prominent part of the forehead.

80°, and the skull bones also of ample dimensions to give plenty of room for the brain. The abdomen should be flat, the chest full, broad, round and very mobile, and its circumference greater at the level of the nipples than at the lower end of the breast-bone. The mobility of the chest walls fluctuates at different periods of life, and after 40 the annual decreased power of movement is constant and considerable.

The skeleton should be hard and strong, the bones of the limbs of good size, not too massive and quite straight. This straightness, however, appears to be relative to the height; for short men, although often possessing powerful limbs, have their bones usually more or less curved. Finally, the carriage of the body should be easy and erect, the head well balanced on the spinal column,* and the latter plainly exhibiting the four graceful curves which artists designate the line of beauty.

The remarks of an old writer on this subject, though not absolutely correct, contain a great deal of truth and are worth recording. He states:—"An athlete should have a small head, brawny arms and legs, a good wind and considerable strength; if a runner, his thighs ought to be long and his arms short; and, if a wrestler, he should be of middle height robust full breasted and broad shouldered; while the best age for competition in any kind of athletic sport is from 18 to 40."

Standard of Growth.

According to statistics compiled in this country and the United States, the annual growth of healthy boys and girls is the same—namely, 2 to 3 inches—until the age of 12. Each child appears to have its own rate, usually some measurement between the above figures; and when the variation in a year is as little as a quarter-

* The weakest spot in the spinal column is at the junction of the dorsal and lumbar curves, for the spinal bones are here proportionately much smaller and more movable.

of-an-inch, some adverse agent, such as diseases of childhood, insufficient food, overstudy, excessive work, or bad ventilation, is checking the natural development. After 12 boys grow quicker than girls, the increase per year between 14 and 16 being with the former 2·4 inches. From that time, however, until the end of puberty conditions of life vary so much, and inherited tendencies of constitution become so pronounced, that no satisfactory standard can be established. Growth is now very erratic, periods of great activity alternating with long periods of quiescence; but it has been observed that growth is more rapid during illness and also in the spring and summer months. From 20 to 25 the increase in height is slower but more regular.

Standard of Height.

What we know of the rate of growth is of little assistance in determining what the proper stature should be between the ages of 16 and 25, and the scientific standard given in the description of a perfect physique cannot always be relied upon. The best results are gathered from observations made in this country, in France and Belgium, and in America, and it is found that nothing influences the height of the individual so much as social position and race.

With regard to social position, the poorer class of the United Kingdom must have been in the early part of this century very short, as one finds the Government offering then a premium of £2 2s. for recruits of 16 who measured 5 feet 2 inches. Fifty years later some seventeen pauper lads who had reached puberty gave a low average of 5 feet and half-an-inch; and at the present time the physicians and surgeons who attend to the outpatient department of the large hospitals can testify to the equally stunted dimensions of youths belonging to the class of indigent poor.

In contradistinction to the above, English public

schoolboys were found at 15 to average 5 feet 4½ inches, and at 16, 5 feet 6½ inches; and so struck was one medical observer with this disproportion that he considered such a stature at so early an age should be regarded with suspicion; but the following tables will show his inference to be a wrong one. These tables also prove that the inhabitants of this country are taller than those of Western Europe, and, as mentioned before, that a difference in class means a corresponding difference in height.*

TABLE OF HEIGHT.

(Statistics of Quetelet, Danson, Boyd, Liharzik and Forbes.)

	18 years.	19 years.	20-25 years.
Natives of Western Europe...	5 ft. 4¼ in. ...	5 ft. 5 in. ...	5 ft. 6½ in.
English Soldiers & Criminals	5 „ 4 „ ...	5 „ 5 „ ...	5 „ 6 „
English Operatives	5 „ 6 „ ...	5 „ 7 „ ...	5 „ 8½ „
English Selected Class ...	5 „ 8¼ „ ...	5 „ 9 „ ...	5 „ 9½ „

STANDARD OF HEIGHT.

(All classes from 12 to 25.)

Age.		Height.	Age.		Height.
12	....	4 ft. 6½ in.	19	....	5 ft. 6 in.
13	....	4 „ 8½ „	20	....	5 „ 7 „
14	....	4 „ 10½ „	21	....	5 „ 7 „
15	....	5 „ 2 „	22	....	5 „ 7½ „
16	....	5 „ 4 „	23	....	5 „ 7¾ „
17	....	5 „ 5 „	24	....	5 „ 8 „
18	....	5 „ 5 „	25	....	5 „ 8 „

Standard of Weight.

There are two methods of arriving at the proper weight of the human body: first, by comparing it with the age and height, and secondly, with the height alone —the former being by far the more accurate one.

An English lad between 3 and 4 years of age should stand 3 feet and weigh 36 lbs.: add 2 pounds for every additional inch of growth until he reaches the 9th year, and the average height and weight will then be 4 feet and 60 lbs. From 9 to 14 the rate of increase

* For correct measurement the man should be stripped and recline in a horizontal position.

per inch is $2\frac{1}{2}$ pounds, and a lad at the latter age should be 4 feet 10 inches to 5 feet high and scale 90 lbs.

Such is the standard of weight compared with age and stature to the commencement of puberty, but a 7 lb. margin must be allowed to meet exceptional deviations. When, however, this limit is exceeded, the same evil causes which were shown to operate against normal growth are preventing the youth from attaining his proper weight.

From 14 to 16, the period of exceptional physical development, the annual increment of weight is as high as 1 stone, but for the remaining four years of puberty it falls to 10 to 12 lbs.

In the adult stage of life the weight remains either quite stationary or is subject to violent fluctuations. It has been observed that slight daily additions take place for about a lunar month, and then, within a few days, the whole increase is rapidly lost; and while this latter change proceeds there are symptoms of disturbed health, such as uneasiness, feverishness, headache, and loss of appetite.

From 30 to 40 there is every year a gain of flesh, and at the latter age the body reaches its maximum weight.

The following table will show that social surroundings have a direct influence upon a man's bulk as they have upon his height :—

	18 yrs.	19 yrs.	20-25 yrs.
English Soldiers and Criminals	8st. 5lbs.	9st. 4 lbs.	9st. 12½lbs.
English Operatives	9st. 9lbs.	9st. 13½lbs.	10st. 7 lbs.
English Selected Class	9st. 10lbs.	10st. 3 lbs.	10st. 10¾lbs.

When the weight of the body is compared with the stature alone, Dr. Aitken suggests for guidance the following rule :—"The weight in pounds of a healthy adult should be equal to twice the height in inches." Such a rule will not square with the idea entertained at our Universities of what a perfect athlete should be,

viz.:—70 inches high and 168 lbs. in weight; nor does it correspond with the results yielded on testing men belonging to two cavalry regiments—the Hussars and 5th Dragoon Guards; for the first averaged 67¼ inches and 148 lbs., and the second 69 inches and 161 lbs. When the dimensions of a few noted athletes are taken, the rule is shown to be even more faulty. Spring and Jackson, the pugilists, were 71 inches in height, and scaled respectively 185 and 196 lbs.; while Parkes, a famous wrestler, was 72 inches and weighed in training 235 lbs.

As a better standard I submit two tables—one framed by myself, for those of my readers between the ages of 20 and 30, who believe they possess the physique of athletes; and the other drawn up for use in insurance offices, the age being fixed at 30:—

TABLE FOR ATHLETES.

(Age 20 to 30.)

5 ft. 1 in. ...	8 st. 6 lbs.	5 ft. 7 in. ...	10 st. 5½ lbs.
5 „ 2 „ ...	8 „ 13 „	5 „ 8 „ ...	10 „ 12 „
5 „ 3 „ ...	9 „ 4 „	5 „ 9 „ ...	11 „ 4 „
5 „ 4 „ ...	9 „ 11 „	5 „ 10 „ ...	11 „ 11 „
5 „ 5 „ ...	10 „ 1 „	5 „ 11 „ ...	12 „ 2 „
5 „ 6 „ ...	10 „ 4½ „	6 „ 0 „ ...	12 „ 7 „

Average increase per inch, equal 5·2 lbs.

INSURANCE TABLE.

(Age 30.)

5 ft. 1 in. ...	8 st. 4 lbs.	5 ft. 7 in. ...	10 st. 8 lbs.
5 „ 2 „ ...	9 „ 0 „	5 „ 8 „ ...	11 „ 1 „
5 „ 3 „ ...	9 „ 7 „	5 „ 9 „ ...	11 „ 8 „
5 „ 4 „ ...	9 „ 13 „	5 „ 10 „ ...	12 „ 1 „
5 „ 5 „ ...	10 „ 2 „	5 „ 11 „ ...	12 „ 6 „
5 „ 6 „ ...	10 „ 5 „	6 „ 0 „ ...	12 „ 10 „

Average increase per inch, equal 5·6.

When the height is above 6 feet, the increase of weight per inch should be 5½ lbs.; but tall men are not suited for severe muscular exertions. The size of the

heart in many cases is not in proportion to their bulky frame; and although they may be gifted with magnificent muscles, the respiratory and circulatory powers are generally far below the average.

In conclusion, let me add that when the weight is taken the man should be naked, the bladder and bowels emptied and to diminish other sources of error a definite time appointed—for instance, immediately before breakfast.

Standard of Chest Capacity.

The capacity of the chest indicates very fairly the degree of development of the heart and lungs, and also the strength and vitality of the individual. It can be estimated with great exactitude by simple measurement of the chest walls, and by means of an instrument specially designed for this purpose, called the "Spirometer."

The proper method of measuring the circumference is as follows:—The man, previously stripped, raises his arms to the utmost and brings them slowly down to his side; and while the lungs are in this condition of complete expiration, the tape is passed round the chest at the level of the nipples, and the number of inches recorded. After a deep and prolonged breath, the tape is once more used, and the difference in inches of this and the former measurement gives the actual mobility of the chest walls.

Some observers have endeavoured, but not with marked success, to establish a ratio between the circumference of the chest and the body's weight, and likewise between the mobility of its walls and the height. They say, above 11 stone 7 lbs., every additional inch of girth should add 10 lbs. to the weight; and above 5 ft. 8 in., every inch of stature should be represented by a proportionate increased mobility of the walls of the chest.

The standard adopted for the army, viz., 34 inches for

men of 5 feet 4 inches to 5 feet 10 inches, and 35 inches for those above 5 feet 10 inches, is too low for athletes; indeed, 100 undeveloped students of 19 gave an average of 33 inches. Dr. Allen's table of the stature and chest circumference in men of 30 is by far a better one.

STANDARD OF CHEST CIRCUMFERENCE.

(Age 30.)

5 ft. 1 in.	...	34 inches.	5 ft. 7 in.	...	38·1 inches.
5 „ 2 „	...	35·1 „	5 „ 8 „	...	38·5 „
5 „ 3 „	...	35·7 „	5 „ 9 „	...	39·1 „
5 „ 4 „	...	36·2 „	5 „ 10 „	...	39·6 „
5 „ 5 „	...	36·8 „	5 „ 11 „	...	40·2 „
5 „ 6 „	...	37·5 „	6 „	...	40·8 „

The spirometer registers the number of cubic inches of air which can be expelled from the lungs by the greatest effort, and this measurement—termed the "vital capacity"—supplements most effectually the other method of determining the size of the thorax.

Dr. Hutchinson, the inventor of this contrivance, states that there is a constant and uniform relation between the size of the chest, judged by the vital capacity, and both the height and weight of the body; and Professor Humphry, the well-known anatomist, agreeing with him, says:—"The amount of expelled air will indicate the minute difference of 1 inch in height and 10 lbs. in weight."

Dr. Hutchinson's table of observations, extending over 5,000 males of all classes, and of all ages from 15 to 55, constitutes the best standard.

STANDARD OF VITAL CAPACITY.

Under 5 ft.	...	135 cubic ins.	Under 5 ft. 7 in.	...	225½ cubic ins.
„ 5 „ 1 in.	...	175 „	„ 5 „ 8 „	...	229 „
„ 5 „ 2 „	...	177 „	„ 5 „ 9 „	...	238½ „
„ 5 „ 3 „	...	189 „	„ 5 „ 10 „	...	246 „
„ 5 „ 4 „	...	195½ „	„ 5 „ 11 „	...	250½ „
„ 5 „ 5 „	...	203½ „	„ 6 „	...	260½ „
„ 5 „ 6 „	...	214 „	Over 6 „	...	276 „

Expectation of Life.

From what has preceded in this chapter, the expectation of life ought to be greater among the select classes of society than with the less favoured ones. This is so, notwithstanding the fact that members belonging to the former expose their lives to exceptional risks by travelling in savage or semi-civilized countries, by greater exposure to extremes of climate, and by entering such professions as the army, navy, Indian and Colonial Civil Services.

Established authorities state that an individual of this fortunate grade at 20 years of age may reasonably expect to survive until his 60th year.

CHAPTER III.

FOOD.

The Classes of Food.

The Food of the human race may be divided into four distinct classes, namely :—

The Albuminous or Nitrogenous.
The Saccharine or Starchy.
The Oleaginous or Fatty.
The Mineral or Saline.

The condiments, or pseudo-foods, such as alcohol, tea, coffee, etc., are often, for convenience sake, described as a fifth class ; but all these substances practically fall into one or more of the above groups.

Indeed, there is hardly one article of consumption which can be regarded as a pure type of any class ; some contain two or three ingredients ; others, like milk, all four. If, however, examples be desired, the white of egg, sugar, butter, and table salt are fair representatives of each of the four divisions of human food.

Combination of the Four Classes of Food.

If life is to continue with ease and pleasure, a man's diet must consist of a judicious blending of the chief members of the four classes—the proportion of each constituent varying with his occupation and the land in which he labours—and the addition of one or more of the condiments. This assertion cannot be controverted by the fact that certain races of men—such as the hunter of the pampas of South America, who satisfies his hunger with the dried flesh of the buffalo, but seldom tastes vegetables, and the Greenlander, whose food is principally animal fat and oil—maintain a vigorous existence upon one only of the above groups, for these races of mankind

live in a primitive manner, and have inherited from their forefathers the ability of digesting a particular form of sustenance.

In order to convey a clearer knowledge of the principal articles of diet, each will be described under the class of which it contains the largest percentage—thus, beef will be considered with the albuminous foods, and oatmeal with the saccharine; notwithstanding that the former possesses no mean proportion of fat and salts, and the latter 12 per cent. of albumen.

The Albuminous or Nitrogenous Food.

The members of the albuminous group differ from all other nutritive substance by always containing in larger or smaller amount nitrogen. This element is of the utmost importance in the preservation of human tissue (especially muscle); for, through the wear and tear of life, it escapes daily in the excretions, and daily must be replaced.

The value of a food depends upon whether it pleases the palate, is easily digested, readily assimilated—converted into flesh and blood—and the presence of three or four of the constituents.

Meat, fish, cheese and eggs answer the above requirements, and, when combined with the saccharine class, form a diet which best sustains human existence and develops the largest amount of vital energy under every circumstance of toil, season and climate. There are two kinds of albumen—animal and vegetable—the former by far the superior, as it is more palatable, more easily masticated and better digested. A brief account will now be given of the principal albuminous foods.

Meat.

Beef, the best portions of which are the chine and thick ribs, possesses a closer texture and more red juice than any other kind of meat and, besides, is more easily reduced in the stomach.

Veal, since calves are no longer bled to death, is more

readily digested, and for delicacy of flavour "the sweet-bread" cannot be equalled.

Mutton is very suitable for men who lead sedentary lives, for women, children, and invalids. It is more nutritious but not so finely flavoured as lamb.

Pork ranks below both mutton and beef; this is owing to the toughness of its fibres and the large amount of fat, faults which seriously interfere with the action of the gastric juice. The young flesh is, however, more tender, but by no means economical eating, for it wastes very much in cooking.

Soup and broths by themselves are not suitable for daily consumption, they do not promote the flow of saliva, and require as much digesting as the meat from which they are prepared.

The following table gives the percentage of nitrogenous substances, fat, and water in every 100 parts of beef, mutton and pork:—

	Beef.	Mutton.	Pork.
Nitrogenous substances ...	25·	23·4	24·3
Fat	2·5	3·	6·
Water	72·5	73·7	69·7
	100·	100·	100·

Poultry and game have not the same food value as butchers' meat: they are richer than it in the phosphates, but yield one-twelfth only of the quantity of the iron salts. Game is superior to poultry on account of the small proportion of fat it contains, but the solubility of the fibres varies considerably, and depends to a great extent on the time the flesh is kept before being sent to table. Turkey and rabbits claim the precedence for speedy reduction within the alimentary canal. Poultry, Game and Eggs.

Eggs, the best form of concentrated nourishment, have the same nutritive powers as poultry and game. Analysis shows an egg to consist of one part (by weight) shell,

six parts white and three parts yelk; the white, again, yields two-thirds water and one-third albumen and fat.

Fish. Fish, with one exception, "red salmon," is inferior to meat or poultry as an article of food. And as an instance of the lessened vitality such a diet produces, I may mention that the women of the fish-eating tribes of the Esquimaux and the New Zealanders never bear more than three or four children. Whitebait and smelts stand first for delicacy of flavour. Crabs are more nourishing and quicker digested than lobsters or oysters, and the last have not the valuable properties popularly ascribed to them. When red salmon can be digested, it is equal as a nutriment to its own weight of beef or mutton.

Cheese and Milk. Unfortunately the albumen of cheese (caseine) cannot be readily dissolved and absorbed by everyone: were this otherwise, considering that one pound of cheese yields as much nitrogen and more fat than two pounds of meat, this article of food would rank first for sustaining life. For this reason any great consumption of cheese is restricted to men who follow laborious occupations in the open air, and their ability to digest the substance during mature life, if not inherited, is certainly promoted by the fact that it has been eaten daily from a very early age. Nevertheless, other classes, not so favoured, should include in their diet a small portion of some kind of cheese, as it undoubtedly assists in the digestion of the meal.

Cow's milk, which is more palatable but not so rich in solids as that from the goat or ass, should have a specific gravity of 1028·, and one pint is equal to $2\frac{1}{2}$ ounces of dry nutriment. It is a most suitable fluid in the preparation of farinaceous principles as sago, arrowroot and tapioca, but the combination with egg alone is not a nutritious or easily digested mixture.

The Saccharine or Starchy Foods.

During the warm months of the year, or while residing in tropical countries, or when the adipose tissue of the body needs increasing, the saccharine constituents of food should form a large percentage of a man's diet. Certain of them, notably fresh fruit and vegetables, are particularly essential in the convalescent stage of illness, and also, when, from other causes such as a perverted condition of the blood, inherited or acquired, the nutrition of the body is lowered.

The saccharine group does not develop weight for weight so much vital energy as the oleaginous, but their speedier solution and assimilation by the digestive organs make them of more service to the economy.

The combustion of these two principles of human food yields 75 per cent. of a man's available energy; and they likewise form energy-producing substances which, stored up within the nerves and muscles, are available for future use. Indeed, it would not be far from the truth to assert that the starchy granules subserve the generation of nervo-muscular force, and the fat of that energy which is dissipated as heat.

In describing the saccharine class, the members of it can be conveniently grouped into those which contain 5 to 15 per cent. of nitrogen, such as wheat, barley, oats, rice, maize, peas, lentils, and millet; those which contain less than 5 per cent., as potatoes, fruit, and green vegetables; and lastly, those which are practically destitute of this element, as arrowroot, tapioca, sago, and sugar.

Wheat.

Wheat of all the cereals has the most nutritive properties, and "semolina," prepared from the finest and hardest grain, is its choicest flour.

Although the ease with which bread is masticated is relative to the quality of the meal, yet it is found by experience that a loaf manufactured from a good seconds is better digested. Moisture interferes with the proper

division by the teeth, hence it is that stale bread is more thoroughly masticated than new.

Twenty-one ounces of good wheaten flour are required to make a pound loaf, and this should give the following proportion of the four classes of food:—

Nitrogenous	$2\frac{1}{4}$	ounces.
Saccharine	$10\frac{3}{4}$	"
Oleaginous	$\frac{1}{8}$	"
Minerals (salts $\frac{5}{8}$, water $2\frac{1}{4}$) ...	$2\frac{7}{8}$	"
	16	"

Biscuits are a concentrated form of bread: for they contain one-third more flour but a proportionate smaller quantity of water. It is the deficiency of the latter which makes them harder to digest and consequently of less value as a food.

Barley. Barley was so highly esteemed by the ancient Greeks that they trained their athletes upon bread made from the meal. It contains more nitrogen than wheat, and is richer in iron and phosphatic salts, but the presence in the flour of the sharp husks of the outer covering of the seed lessens its nutritive properties. For this reason bread and biscuits made from barley are unsuitable for dyspeptic people, or for those who are liable to any irritative affection of the bowels, as colic, diarrhœa, or dysentery.

Oats. Meal made from oats can be eaten for a very long period without the appetite failing, and it also keeps better than any other flour. This cereal contains more nitrogen, fat, and salts, and develops more vital force than either wheat or barley; nevertheless, the same objection obtains as in the case of the latter, and reduces the value of oatmeal far below that of wheaten flour.

Maize and Millet. Maize and millet are inferior and cheaper grains, taxing severely the digestive organs; the former is used largely in workhouses and prisons, and likewise among the poorer community of England and Ireland.

Peas, beans, and lentils are consumed to a vast extent in other European countries; but, although they all contain much vegetable albumen and are rich in phosphates, the flavour of the meal prepared from them is peculiar, and to many people most objectionable; hence, their use is a very partial one with the English race. Peas, Beans and Lentils.

Rice and potatoes appear to occupy an intermediate position between the above cereals, and such purely saccharine substances as arrowroot tapioca and sago. Rice and Potatoes.

Rice is a valuable grain and deservedly called the "corn" of tropical and sub-tropical lands, where millions of human beings depend upon it for their staple support. It contains 6 per cent. of nitrogen, and is so easy to digest that within one hour no trace of this food can be found in the stomach. Rice should lie six months in the granaries before being eaten, as when new it produces dyspepsia, diarrhœa, and a tendency to rheumatism.

The potato yields 2 per cent. of nitrogen, much starch and very many salts; it is therefore a most useful and sustaining vegetable, and the vigorous health of the inhabitants of South and South-West Ireland plainly show how well life can be maintained by races who subsist almost entirely upon the root. Of the various kinds the regent, when old and floury, is found to be the most nutritious.

The seeds of many plants contain nitrogenous, starchy, and oily bodies, and if taken in small quantities are valuable adjuncts to the diet; when, however, eaten by themselves they are reduced very slowly to a state of solution. Seeds of Plants.

Fruit and green vegetables possess a low nutritive property; the one should be eaten ripe, and the other while young and fresh: their beneficent influence in perverted conditions of the blood, more especially in scurvy, has already been alluded to. Green Vegetables and Fruit.

Sago, Arrowroot and Tapioca.

Sago arrowroot and tapioca are important additions to the nitrogenous and oleaginous foods. In preparing them for the table water must be added, for they contain very little of this element—a deficiency which renders them all in no little degree non-appetizing and difficult of digestion.

The Oleaginous or Fatty Foods.

The fatty constituents of food are necessary in all countries, and their large consumption by the Greenlander has already been pointed out. The inhabitants of southern as well as northern climes feel the need of this principle, and cultivate the olive to supply their want; the Bedouins drink butter, either pure or mixed with herbs, by the cupful, at least once a day; and still nearer the equator one finds the Hindoo mixing "ghee" with his rice. It may be confidently asserted that for every degree of latitude towards the poles there should be a proportionate increase of either vegetable or animal fat, for both are equally serviceable in the human diet.

Races of men who abstain from oleaginous food have a large mortality from scrofulous diseases, and the immunity of the people of Iceland from this scourge of mankind is due to their large appetite for fat; indeed, the benefit of cod liver oil in one form of scrofula, viz., "consumption," is widely known and fully appreciated.

Animal Fat.

Fat plays an important part in the formation of every human tissue, more especially of nerve and nerve cells, and undoubtedly exercises a marked influence upon the assimilation of albumen; for the latter reason its consumption should be encouraged in men who are thin, delicate, and easily exhausted. It also renders the meal more appetizing, lubricates the walls of the intestines and the contents of the lower bowel, thereby facilitating the speedy and safe removal of the inert mass from the alimentary canal.

Attention has been directed to the power which fat

possesses of generating heat and maintaining the warmth of the body: it has been calculated that one ounce of butter will create within the frame ten times more heat than the same weight of lean meat, and doubtless this property explains the strong desire for oleaginous food during cold seasons, and when residing in countries remote from the equator.

The chief forms of animal fat are cream, butter, fat of meat cheese eggs and fish. Cream is the most delicate, and when mixed with curaçoa has been used as a substitute for cod liver oil. Butter was not prepared until the 13th century, and stands next to cream for agreeableness of flavour: both are easily digested even in the hottest months. Its average consumption should be one ounce per diem. Bacon is, after butter and milk, by far the best form of animal fat: it is one the palate does not tire of, and can be eaten by many people during the summer. One pound of this substance yields twelve ounces of fat.

The principal fats derived from a vegetable source are olive oil, and the oily principles of cereals such as oatmeal, and seeds like cocoa. They all have a delicate flavour, and the beverage prepared from cocoa-nibs can often be taken by individuals who dislike the other forms of fat. Unfortunately, however, manufacturers, in their endeavours to produce a palatable article, remove too much of this essential principle from the nibs.

Mineral Class.

The mineral class consists of water, oxygen and salts of iron, soda, potash and lime.

The salts and water form no mean percentage of the articles of food already described, and, although by themselves unable to create much energy, they regulate its production within the body to an appreciable extent; indeed, any food substance deficient both in salts and in water is invariably innutritious.

Table salt has been shown by physiologists to lessen the waste of muscular tissue, and its need by man and beast is pressing and constant. It is well known that animals will wander immense distances in search of saline springs, and in inland countries this mineral is an important article of commerce for purposes of sustenance.

Water. The presence of water renders in a great measure fresh meat bread and vegetables of more value than dry or stale food; and the many duties it performs in the human economy testify sufficiently to its extreme usefulness.

By evaporation from the surface of the skin it maintains the temperature of the body at nearly the same degree of heat throughout all seasons of the year. forms the greatest portion of the digestive fluids, and considerably aids them to soften and dissolve the masticated meal. When the nutriment is reduced to a soluble condition, water facilitates its passage into the blood stream, and from there to the parts surrounding the vessels.

Upon the presence of water depend the proper liquidity of the blood, the right amount of moisture of the tissues, the transformation of the nutriment into living flesh, and the removal of dead and effete matters. When not freely ingested, the natural repair and waste of the body is hindered and many products of wear and tear remain within it undissolved, irritating by their presence either the tissues where they originate, or the eliminatory organs, as the skin and kidneys, where they should escape.

For the above reasons the supply of water should never be stinted. It is absorbed greedily after exercise, remains a considerable time within the system, and may be taken under any circumstances with perfect safety, providing, in extremely cold weather, it be retained a few moments within the mouth.

The qualities of good water as revealed to our senses are transparency, brilliancy, and an absence of hardness colour odour or sediment; but a chemical analysis is further necessary to detect the more subtle organic impurities.

Oxygen.

The last member of the mineral class of aliments, "oxygen," abounds in the atmosphere in the proportion of one volume to four of nitrogen. This gaseous food enters the blood stream through the delicate walls of the lungs, and within the vessels and in the hidden recesses of the body around them, changes are effected both in the nutriment and living tissue which are too occult to follow. It suffices to say that the outcome of this chemico-vital action is nervo-muscular energy, electricity, and heat; phenomena which in their totality constitute life.

Pseudo-Foods or Condiments.

The condiments, the chief of which are alcohol, tea, coffee, pickles and spices will now be described. These subsidiary foods are not nutriment in the ordinary acceptation of the term, but hold a position intermediate between the foods proper and drugs. Like the members of the group just considered, their power of generating energy is very small, although some—as alcohol for instance—can, when no food is taken, marvellously sustain the vitality of the body for a lengthened period.

All, however, by stimulating the appetite and the digestion, promote the nutrition of the frame, and thus indirectly create vigour.

Alcohol.

On account of the profound mental and physical degradation of those who habitually consume too much of this potent agent, no article of diet has attracted more attention than alcohol. Its advocates would elevate it to the dignity of a food proper, while its detractors would degrade it to the level of a poisonous drug.

In reviewing the authenticated action of this much

maligned condiment upon the human economy, I would remind my readers that the abuse of any article of diet is no warranty for denying its efficacy as a food.

Alcohol is not changed in the alimentary canal into fat, albumen or any product of these (such as soaps or peptones), but either here or in the blood, if the quantity be not too large, oxygen converts it into sugar.

This conversion into a soluble food material naturally generates energy, and as a matter of fact three-and-a-half fluid ounces of alcohol will furnish one-fourth of the heat required to warm the body for twenty-four hours.

Alcohol, likewise, checks the normal waste of the tissue, especially of fat, and hence intemperate men become corpulent, and temperate ones have a lessened desire for oleaginous food; it also decreases the loss of water from the system, gives tone to the muscles and nerves, and stimulates both digestion and assimilation, frequently to a wonderful degree.

Men and women, enjoying robust health, with good digestion, speedy assimilation, and unexhausted nervo-muscular organs, do not require alcohol in any shape or form: it is for them a costly, unnecessary, and injurious condiment, creating too much blood and overstimulating both the heart and brain; in the latter case the flow of nerve impulses to, and the control over the muscles, are seriously interfered with, and a diminished production of mechanical force is the consequence.

On the other hand, in those conditions of extreme exhaustion of the muscular and nervous organs which attend excessive exertion or the ravages of disease, alcohol is a most powerful remedy, if not, indeed, a perfect food. Thus, when men after great toil are required to undergo further labour, alcohol cannot be

replaced by any food or drug, and its efficacy is much increased if to every ounce of spirit a quarter of an ounce of beef extract and ten ounces of water be added. In the convalescent stage of illness alcohol mixed with water or milk is most grateful to the palate, and readily digested: under its influence the nervous system grows calm, the enfeebled organs regain their wonted activity, the wasting of the body is stayed, and the weight increased. Sleep now becomes quiet and refreshing; and despite the fact that large quantities of alcohol are frequently given to patients unaccustomed to the condiment, no bad effects upon the brain and muscles result.

There are many individuals in all crowded cities who, although able to follow their occupation, are not robust. Their digestive and assimilative powers being feeble, they are badly nourished, have a languid circulation, an easily disturbed nervous system, and a low production of muscular energy. Alcohol is a valuable adjunct to their meal, and when judiciously given will, in time, bring about a more vigorous condition of the mind and body. Such men may advisably take daily two ounces of good spirit diluted with a pint of aerated water; or, if wine and malt liquor be preferred, five ounces of the former, or one pint of the latter, may be substituted.

Spirits and strong wines when taken undiluted provoke thirst and irritate the stomach, and at meal-time this irritation hinders the flow of gastric juice. In addition, alcohol in this form converts the soluble food into coagula difficult to dissolve, passes less easily into the blood-stream, and when there is more slowly changed into sugar.

Excessive use of Alcohol.

When used to excess its action upon the body is briefly as follows:—At first partial paralysis of that portion of the brain which controls the muscular movements, so that the man staggers, the face becomes flushed and the

pupils dilated. Later on nutrition is impaired, fat being deposited in all the vital organs and seriously interfering with their functions, while the blood undergoes changes allied to fermentation, and renders the tippler very liable to contract contagious and infectious diseases. Lastly, there is diminished power both to endure bodily and mental labour and exposure to extremes of heat and cold.

Tea.

Tea, like the foregoing condiment, has its use and abuse. Its action upon the human economy is briefly as follows:—It stimulates the skin and nervous system, more particularly the former; but owing to its large percentage of tannin, it greatly diminishes the flow of gastric juice; and, unlike alcohol, promotes a rapid wasting of the tissues.

After a moderate ingestion of this beverage there is a certain alacrity to encounter exertion, fatigue is also better borne, and, although a good deal of surface heat is experienced, copious perspiration speedily ensues, the evaporation of which from the skin produces a marked reduction of the temperature and an accompanying delightful and refreshing sensation of coolness.

Residents in tropical countries claim another property for tea: they assert, and on very sure grounds, that it has the power, if not of purifying, at least of lessening the injurious effects of impure water.

The conclusions from the above are that this condiment is a suitable drink, especially in the summer, for those people who, with a good appetite and a brisk circulation, have an inactive skin, or are apt to eat too much; it is likewise a desirable beverage for inhabitants of hot climates, who are obliged to lead an active life. On the other hand, tea is a bad stimulant after severe muscular exertion, for it renders the prostration more profound; neither should it be habitually taken by those who with an excitable nervous system, suffer from sleepless-

ness. More pernicious still is its action upon the feeble, ill clad, badly nourished, and such as perspire freely, and have a languid circulation.

Tea should be diluted with milk, which diminishes any ill effects, and some solid food should be eaten with it—such as bread and butter—never meat or fish, for the tannin converts their fibres into a tough indigestible substance of the nature of leather. It should be drunk two hours after a meal, and at a late period of the day. The practice of imbibing hot and strong infusions in the early hours of the morning, when the nervous system is relaxed by sleep and warmth, is a reprehensible one, and, like that of excessive tea drinking, will eventually destroy the appetite, enfeeble the muscles, overstimulate the brain and skin, and bring about loss of bodily warmth, debility, wakefulness, and an intractable form of dyspepsia.

Coffee differs in many respects from tea. It stimulates the nervous system less, and the heart more; has less power of promoting tissue change; rather retards the function of the skin; and, owing to the smaller amount of tannin, does not interfere so much with digestion; milk again, when added, will not lessen its action upon the organism. Coffee.

For these reasons coffee agrees better with the poor, the small eater, and the dyspeptic; it is a more suitable beverage for breakfast in the winter months, and can be taken without injury immediately after a meal or fish meal. Very strong coffee, or excessive ingestion of it, is injurious; it causes irregular pulsations of the heart, muscular tremors, indigestion, depression, and wakefulness.

Pickles and spices are also important condiments. By stimulating the appetite they maintain a due nutrition of the body under such disadvantageous circumstances as Pickles and Spices.

extremely hot seasons, and prolonged residence in the tropics; and were it not for these aids to the appetite natives of temperate climates would often be unable to exist in countries like India. When the individual has become accustomed to his altered surroundings these artificial stimulants should be by degrees discontinued, otherwise they may produce an unnatural craving for food.

Effects of Impure Food.

A few remarks upon the mischief wrought upon the body by bad food, impure water, and foul air, will not now be out of place.

Unwholesome food first deranges the digestive organs, and, secondly, lowers the general vigour. The sequence of events is usually heartburn, flatulence, ulceration of the mouth and gums; then follow painful spasm of the stomach and bowels, sickness and diarrhœa, and, later on, boils and skin diseases: nevertheless, it is remarkable how the constitution, either from gradual usage or from inherited capacity, accommodates itself to the quality of the nutriment, for the poor of large towns habitually live—and in a manner thrive—upon meat, fish and fruit, which, if eaten by their wealthier neighbours, would, inevitably, set up the symptoms of an irritant poison.

Water is rendered impure by excess of saline substances, and by contamination from an organic source. Each impurity produces its special disorders; the former, headache, indigestion, and constipation; the latter, sickness, diarrhœa, diphtheria and typhoid fever.

Air is fouled by organic particles which emanate from the human skin and lungs, sewers, slaughter-houses and marsh lands; and by inorganic ones—solid carbonaceous products—given off by the combustion of gas, coal, oil and candles, of which the last are the most pernicious. They are at first recognized by the senses of smell and taste, but these, after a while, become accustomed to their presence, and fail to detect them in the atmosphere.

Both impurities produce heaviness, lassitude, loss of appetite and energy, sickness and pallor. To the organic ones may also be attributed diphtheria, typhoid, ague and, perhaps, cholera.

CHAPTER IV.

NUTRITION OF THE BODY.

HUNGER AND THIRST. DIET AND DIGESTION.

Laws of Nutrition.

OUR knowledge of the laws which preside over the nutrition of the human body is limited and far from perfect, and until we have a fuller, and more correct view of them, it will be impossible to frame a perfect dietary. At the best, as observed by an eminent worker in this field of science, we can but speak of a "normal diet" as we speak of a man possessing an "average intellect."

A review of the results of investigations into nutrition will show that much exact information has been acquired, and from these ascertained facts many true and concise deductions, as to what is a proper diet, can be made.

Every individual hourly parts with the various forms of vital energy; and the close observer notices, that this continuous loss of the principle of life reveals itself by pallor, chilliness, lassitude, and diminished weight.

This loss must be made good or the man will die. So at periodic intervals he takes food rest and exercise.

When, however, the food is in excess a double evil obtains: there is the waste of useful nutriment, and a large and unnecessary expenditure of energy in the rejection of the superabundance. Every ounce of sustenance which passes into the blood must become living tissue before it can reappear in the excretions as waste products; and advocates of heavy dinners ought to know that this change or metamorphosis is an extremely exhausting process.

No doubt much of the meal never enters the circulation, but remains in the intestines, more or less altered by the action of the digestive secretions, and while there gives rise through fermentation and putrefaction to a great deal of constitutional irritation.

On the other hand, if the ingestion of food does not meet the daily requirements of the body, the expenditure of energy slackens, the flame of life burns less fiercely, and the man grows weaker and weaker.

To avoid both errors nature has planted within us a regulating instinct by which the relation of the INCOME and EXPENDITURE of vital force is adjusted; and to aid still further this adjustment there exists within the tissues, more especially the muscular and the nervous, a stock of stored-up energy. This stock is always available for sudden demands upon one's nervo-muscular system; but a wise man should have more concern for this reserve of vital power, than he has for that mechanical form of stored-up energy—"his balance at his banker's."

From the foregoing remarks three deductions may be made:—First, when the proper quantity of food is eaten, a man's daily loss of strength is replaced without any drawing upon his stored-up energy; and his weight, after hourly fluctuations, within narrow limits, remains stationary. Next, when an excess is taken, the loss is repaired, the stock added to, and the body's weight increased. The gain is here an illusory one, for so great is the expenditure of nervo-muscular force and heat in the removal of the superfluous food that the slight addition to the stock is unequal to the extra demands which the increased weight will make upon the vital powers—that is, the man makes so-called flesh, but he does not necessarily make strength. Lastly, if the food be insufficient, the daily loss of vigour is made good by the dissipation of the stored-up energy, and while this is

disappearing the man loses weight. When the reserve has quite gone, the expenditure of the man's energy falls each day far below the average amount, and with this fall the body still wastes, but at a slower rate.

Evils of an excessive diet.

The most pronounced symptoms of habitual over-eating are indigestion, torpidity of the brain and muscles and fœtid breath; but according to the presence in the diet of an excess of any one of the four classes of food, so will other signs of disordered health appear.

The albuminous constituents are the most often taken too largely, and as the decomposition of albumen releases an oily substance the individual gains a little fat. This increase of weight is, however, soon lost, for a large meat diet produces a loathing of food, and a serious change in the composition of the gastric juice. The stomach secretion now fails to convert the fibres of meat and fish into peptones; imperfect forms of which enter the blood, and not undergoing there complete oxidation, they set up dangerous irritation of the kidneys, skin and liver. Such irritation is a fruitful source of gout, skin disease, and albuminous urine.

Athletes during the winter months, besides forgetting to lower their consumption of meat, often neglect muscular exercise. They are, therefore, especially liable to derangement of the above organs; indeed, the worst form of gout that has come under my notice was in a well-known oarsman, who, after abruptly discontinuing all forms of sport, engaged, without altering his diet, in a sedentary occupation. Men who eat freely of albuminous food must take plenty of outdoor exercise in order to favour the thorough oxidation and removal from the body of the products of digestion, or their health will suffer. Even with this precaution such a diet is not to be commended, and, probably, is detrimental to activity and clearness of the mind. Does not Sir Andrew Aguecheek

ascribe his imbecility to the fact that "he was a great eater of beef, and he believed it did harm to the wit?"

A preponderance of the starchy and fatty constituents of food produces less inconvenience. It checks, however, the regular waste of the frame, and, if supplemented with a fair proportion of meat or fish, causes an increase of adipose tissue and of weight.

Excess of farinaceous substances creates too much lactic acid in the blood, and predisposes the individual to rheumatism; while excess of fat alone in the diet is followed by rapid formation of bile and derangement of the liver.

The mineral class is rarely taken beyond the natural requirements, except under compulsory circumstances, such as long sea voyages; and no evil results ever attend a large ingestion of water, for the kidneys and skin safely and speedily remove what is not needed.

Evils of an insufficient diet.

When the daily food (it is of the albuminous constituents that I now speak) does not satisfy the wants of the body, the impaired nutrition is only too plainly indicated by the diminished strength and weight. For every ounce of missing nutriment an equivalent amount of the man's fat is oxidized in order to nourish the nerves and muscles, and the disappearance of the adipose tissue gives to the frame an emaciated aspect.* The organs of the body become less active, while the cold extremities, and the inability of the brain and muscles to endure continuous labour, reveal a lower production of energy. As a natural consequence of this functional inactivity, excrementitious matter, and other products of the wear and tear of life, fall far below their usual amount. The appetite, at first sharpened, soon flags, and there is again a distaste for food. The gastric and other digestive juices

* This condition is plainly seen in jockeys, who have wasted to reduce their weight.

also undergo retrograde changes; they are either secreted in smaller quantity, or the blood fails to yield the ferments which have the power of dissolving the masticated meal.

If the saccharine and oleaginous constituents be both insufficient, the man loses flesh, but when the latter alone is wanting he becomes predisposed to develop scrofulous disorders. It is most reprehensible for the trainer to deprive athletes, while under their care, of food containing fat: the custom serves no wise purpose, and lessens for some time afterwards the man's power of digesting this substance. To this perversion of nutrition can be traced the death from consumption of many a promising youth. The absence of salts from the diet is so rare as to need but a passing comment. In early life it is not unusual for the salts of lime either not to be sufficient, or else not to be properly assimilated. The bones, under such circumstances, become soft, and curve easily on pressure. In later years the same trouble prevails with the iron salts; want of colour and of energy are then the prominent symptoms.

Deprivation of water.

The deprivation of water is, however, attended with serious injury to the health. Exercise powerfully stimulates the functions of the skin and lungs,* and through these channels water escapes freely from the system, causing the tissues to become dry and the blood less fluid.

Now every organ of the body, and particularly the muscles, depends for its efficient action upon the maintenance of a certain degree of moisture; and the blood, likewise, unless it has the right density, cannot discharge its double function, namely, a circulating distributor of nutriment, and a remover of waste materials. The feeling of thirst usually impels us to preserve this requi-

* When the exercise is severe the daily loss of water from these organs is increased 80 per cent.

site moisture, and when the want remains ungratified, restlessness, broken sleep, dislike for food, loss of strength, and diminished weight inevitably ensue.

Many trainers will, at any cost, reduce the weight of their pupils, and not only disregard the sense of thirst, but, further, deprive the body of moisture by the use of vapour and Turkish baths, and by insisting on severe exercise in flannels.

Nature, in the marvellous faculty which the skin and the lungs possess of absorbing water, either from a bath or from the atmosphere, has provided a safeguard, although an incomplete one, against this dangerous tampering with the vital powers. The following are authenticated instances of this provision. After severe labour, extending over an hour and a quarter, a man was found to have lost three pounds; he was then placed in a bath heated to 95 degrees Fahrenheit, and within half an hour he had recovered eight ounces. Again, two jockeys had, by "wasting," reduced themselves far below their proper weight. Just before the race, one drank half a glass of wine, the other a cup of tea; and this small amount of fluid, in both cases, started the body's wonderful power of absorption. Within an hour or so the former gained two and three quarter pounds, the other as much as six pounds, and neither was able to fulfil his engagement to ride.

Other evil consequences to the nutrition attend abstinence from water: the digestive secretions have not their right degree of fluidity, and therefore cannot convert the starch granules of the food into sugar; while for want of the requisite vehicle to dissolve the waste products of the tissues, these are retained within the body and become a source of danger to life. Dr. Smith especially noticed the latter evil, and advised trainers to give their men, every fourth morning, half a pint of cold water, and to

repeat this twice at intervals of half an hour, in order to facilitate the solution and removal of the above deleterious substances.

Hunger and Thirst.

The two wants of the body—"Hunger and Thirst"—have been, to a great extent, considered in the preceding description of the disturbance of the nutrition produced by excessive or deficient food.

The exact way in which the manifestations of these wants arise is not easy to trace, but the sensations appear to be located in some nervous apparatus situated in the throat, stomach and intestines.

The chief indications of thirst are dryness of the throat and mouth. The sensation can be relieved, not only by drinking, but by gargling this part of the body, or by bathing the arms and hands with cold water. Gnawing pains, first in the stomach and then in the bowels, with a feeling of emptiness and faintness, are the common indications of hunger. Still, these local sensations are very deceptive and often masked when the mind, as in studying, is strongly directed to some object. Other symptoms, as restlessness and disturbed sleep, are, however, unmistakable and disappear as soon as food is taken.

Influence of food on the formation of tissue, and on the production of energy.

Before concluding the subject of nutrition, it would be of interest to discuss two questions. Whether any article of a man's diet has the power of forming or of replacing certain tissues of his body as muscle, nerve, or fat? And whether there is any food substance, or tissue of the body solely concerned in the production of either nervo-muscular energy or heat?

With regard to the first question there is not, at the present time, sufficient evidence to prove absolutely that any food or combination of food can directly replace a particular tissue of the body, whether it be a fat cell or a nerve or muscle fibre. There is, however, a very strong presumption that alcohol, or a diet which contains a large

proportion of starchy and oleaginous principles by preventing the usual destruction of the adipose tissue does favour the deposition of fat within the body. It is, probably, in this way, that the excess of starch in many of the extensively advertised infant foods causes young children to become abnormally stout. In answer to the second question Liebig asserted, and he was until a recent period supported by physiologists, that muscular energy could only be produced by eating albuminous food—more especially animal albumen—a statement which has been conclusively proved to be an erroneous one. Inhabitants of mountainous districts perform arduous journeys on a diet of fatty and starchy substances. Again, horses oxen and insects expend relatively far more muscular force than man, although their sustenance yields little or no albumen. There is, however, every reason to suppose that from the oxidation or destruction within the blood and tissues of the products derived from albumen and starch there does originate "an energy-producing material" which forms an essential portion of nerve and muscle, and is destroyed whenever nervo-muscular force is expended.

That heat is generated either by the combustion of fat contained in the food, or of fat which exists within the body, there can be no doubt. Nevertheless, animal heat is maintained, in some inexplicable manner, when this principle is hardly at all represented in the diet; for instance, carnivorous beasts like tigers are able to produce all the warmth they require on the small amount of fat contained in the flesh they devour.

The saccharine constituents of our meals are also not absolutely necessary for the development of heat, and it is doubtful whether they generate at all this form of energy. Men living in tropical countries subsist mainly on vegetables fruit and rice, and they would not, from

the nature of things need a heat-forming diet. Again, many decidedly cold-blooded reptiles live principally on green food.

These facts will, I trust, dispel for ever from the mind of trainers the idea that certain foods have exceptional properties of not only forming muscle, but likewise of creating muscular energy, and may perhaps prevent them from placing a veto upon many dietary articles which are harmless to the constitution and grateful to the palate.

Formation of a dietary.

The preceding *résumé* of the known laws of the nutrition of the human body indicates the many difficulties in the way of framing a perfect dietary :—one in which all the constituents will be so justly combined that while the right proportion of stored-up energy is conserved, the food taken is just sufficient to develope the required force, to repair the wasted tissues, and to keep the products of the wear and tear of the frame at their lowest possible amount.

In seeking a standard which will approximate to the above, the three chief factors to be borne in mind are the nutritive value, the quantity, and the best combination of the four classes of food. Dependent upon one or more of these factors will be the palatability and digestibility of the particular nutriment, the age and mode of life of the individual, and finally the climate and season of the year. Much assistance in the elucidation of this question has been derived from the study of the diet of our soldiers and sailors, at home, abroad, and on active service ; also of the allowance of food supplied to mechanics in times of great distress, to paupers and to criminals. The nutritive value and digestibility of the principal articles of a man's diet have been already discussed. I shall now proceed to deal with the palatability, the combination, and the quantity of food in so far as they concern the subject under consideration.

Whether any particular nutriment is palatable depends upon its freshness, degree of moisture, appearance, taste, mode of preparation, and ease with which it can be reduced by the teeth. Variety again plays an important part in the enjoyment of the meal. Palatability.

If all these requirements be observed, the digestive fluids are secreted in abundance, the appetite stimulated, and desire created. On the other hand, neglect of one or more of these essentials—especially imperfect dressing or cooking of food—will prevent a judicious and liberal diet from satisfying the natural appetite of the individual.

The following facts in the preparation of food are not so widely known as they deserve to be :—Meat, no matter in what way it be cooked, loses much weight by the evaporation of water ; but this loss, which is least in beef and most in pork, can, however, be lessened by slowly roasting the joint before a not too fierce fire. When roasted, meat has the greatest nutritive value, although some people relish and digest it better either stewed, boiled or baked. In cold weather meat should be kept until the death stiffening has passed away ; for the fibres are then more tender, and the flavour more delicate. The flesh of the leg and face of the animal is best suited for broths, soups, and beef-tea ; and in preparing them the temperature ought never to be allowed to rise above 160° Fahrenheit.

All cereals and vegetables, particularly peas, beans, and oatmeal, require long and careful cooking. Hard water should be avoided, for the lime salts it contains form indigestible compounds with vegetable albumen. Potatoes should be boiled in their skins so as to prevent their valuable anti-scorbutic salts from escaping into the water.

There appears to exist both in men and in animals a wide range of selective power and a great variability in taste. Idiosyncrasies of taste.

This little studied sense should not be disregarded or too sedulously neglected. Instances are numerous amongst one's own acquaintances of the distressing symptoms which follow the eating of such apparently innocent substances as mutton, eggs, sugar, coffee, strawberries and cherries. Again, who has not personally experienced disagreeable sensations after a meal of some (to other persons) harmless nutriment? This selective power has often been recognised among the lower animals, even those so closely allied as the grass-eating ones. Horses, for example, will avoid the cruciferous plants, many of which are largely eaten by man, and yet freely devour the poisonous "aconite." Oxen will not touch either the solanaceous or the mint tribes, and their dislike to the former is shared by sheep and goats; but rabbits eat with impunity "belladonna," and goats the deadly "hemlock." Even animals, differing only in species, as the black and the white rhinoceros, choose for food opposite kinds of vegetation; the venomous plant "euphorbia candelabrum" is harmless to the first but most fatal to the latter. Domesticity seems to have some power in modifying this selective sense, for we find while the dog and cat will feed on bread and butter, their congeners, the wolf and tiger, cannot be induced to eat such food.

Combination of the four classes of Food.

The combination of the four constituents of food varies, as also does the quantity, according to the age occupation and habits of life of the individual, the season of the year, and the climate.

The following proportions are a fair approximation to the truth of what the combination should be, and will be found to consist of one-sixth dry solids, and five-sixths water. If the whole dietary for the day be taken at 120 parts, four by weight should be albuminous, three oleaginous, twelve saccharine, one salts, and 100 water.

When physiologists are better acquainted with the kind and amount of each waste product of life, they will easily be able to compute the nature and quantity of the food necessary to replace the loss. Experimental results in this direction are somewhat meagre, but attention may be drawn to two established facts. First, the nearer the diet approaches to a "scientifically perfect one," the less is the amount of excrementitious matters; and, consequently, the less is the expenditure of vital force. Secondly, small men part with more energy and have more waste products relatively than their taller fellows. Quantity.

From these facts it may be inferred that innutritious food substances should be avoided, and that short individuals should eat proportionately more than their neighbours who possess a larger physique.

In the present state of our knowledge the safest guide to the quantity of food is the organic sense of satisfaction, a sense which is often confounded with the misleading one of satiety. A man should eat "when hungry but not so long as he is hungry."

There are many well-known instances of the wide range in quantity of the daily consumption of food; but the eccentricity, or the savage condition of the men prevents the information from being of much service in the philosophic examination of this question.

A miller lived a vigorous life for eighteen years on a daily ration of one pound of flour and the water necessary to make this into a pudding. Another individual existed for fifty-eight years on a diet of twelve ounces of vegetables and fourteen ounces of light wine a day. On the other hand, the regular allowance per diem of a wandering Cossack is from twelve to twenty pounds of meat; and Captain Parry, the Arctic explorer, saw a young Esquimaux devour, in

twenty-four hours, thirty-five pounds of a varied assortment of food and drink.

One reads also that three Bosjemen ate during the day a whole sheep, and that ten Hottentots finished an ox of medium size in about three days.

Habits and mode of life likewise affect the quantity. Teetotalers for example eat far more farinaceous food than less temperate folk; and men who indulge freely in tea, coffee, alcohol, and tobacco, are usually small eaters.

Allusion has been made before to the manner in which season and climate influence both the amount of food taken and the desire for certain articles of diet. In cold or elevated countries and during the winter months, both the albuminous and oleaginous constituents of the diet should be increased; while under opposite conditions they should be decreased, and their place supplied by the saccharine group.

It has been pointed out also, that at the time of puberty and adult age, the frame is developing rapidly, and the muscular and other organs are acting vigorously. For these reasons the natural appetite for food should at these periods of life be in no way stinted.

What regulates, however, more than any other condition, the quantity of food taken by adults is the nature of the muscular work daily performed; and in order the more conveniently to discuss this phase of the subject, I propose to divide men residing in a temperate climate, like Great Britain, into three classes. Those who do little or no work, those whose labour is not an arduous one, and lastly those whose occupation involves a large expenditure of nervo-muscular energy. In the last class are mechanics, soldiers and sailors on active service, travellers, hunters, and athletes in training.

Diet for Rest.

An average healthy adult weighing 11 stone, and standing 5 feet 8 inches high, who comes under the first

class, can subsist well on a daily diet of 16 ounces of water-free food and 80 ounces of water. This would yield 250 grains of nitrogen and 3,000 grains of carbon, or, in other words, $1\frac{3}{5}$ grains of the former element, 20 grains of the latter, and half an ounce of water for every pound weight of the man's body.

The 16 ounces of dry food should have the following proportion of constituents :—

Albuminous	2·5	oz.
Saccharine...	12·0	,,
Fatty	1·0	,,
Salts	·5	,,
Water-free food	16·0	,,

The ordinary articles of food contain roughly half their weight of water, so the following substances would give the man his pound of solid material and an additional 16 ounces of water :—

Uncooked meat	12	oz.
Uncooked vegetables	10	,,
Bread	10	,,
	32	,,

Professor Huxley has calculated the diet of an individual similarly constituted, but whose occupation places him in the second class, to be about $17\frac{1}{2}$ ounces of water-free food and 100 ounces of water. This scale gives 300 grains of nitrogen and 4,000 grains of carbon, or 2 grains of the former, 25 grains of the latter, and three-quarters of an ounce of water for every pound of the man's weight. The constituents are :— Diet for Ordinary Labour.

Albuminous	4·25	oz.
Saccharine	9·4	,,
Fatty	3·4	,,
Salts	·45	,,
Water-free food...	17·5	,,

And the substances which would yield the above are :—

Cooked meat (very lean)	10 oz.
Cooked vegetables	7 „
Fat and butter	3 „
Bread	9 „
Milk	12½ „
	41½ „

Considering the amount of work daily performed, viz., 450 foot tons, Huxley's allowance of dry food appears somewhat low. I prefer the three next standards, which give an average of 3 to 4 ounces more of solid nutriment :—

	MOLESCHOTT.	PARKES.	Army allowance (during peace).
Albuminous	4·55 oz.	4·31 oz.	3·95 oz.
Saccharine	14·25 „	11·7 „	17· „
Fatty	2·95 „	3·5 „	1·35 „
Salts	1·05 „	1·07 „	1·3 „
Water-free food...	22·8 „	20·58 „	23·6 „

The articles of prepared food which furnish the above are :—

Meat, poultry, fish or game	8 oz.
Eggs, 2 oz.; bacon, 2 oz.; cheese, 1 oz.... ...	5 „
Bread, 16 oz.; other farinaceous food, 4 oz. ...	20 „
Vegetables and fruit, 8 oz.; sugar, 2 oz.... ...	10 „
Milk	30 „
	73 „

Diet for laborious occupation.

Should such a man be engaged in labour which places him in the third class, the albuminous and saccharine constituents of his diet, as well as the fluid food, must be increased. The proportion of meat, however, can be diminished if butter, oil, and nitrogenous cereals, such as wheat, barley, peas and beans be given more abundantly. When the meat daily consumed amounts to 10 ounces or more, it should be divided into two equal portions, and taken at intervals of at least eight hours in order to avoid undue taxation of the digestive powers.

Professor Parkes' standard of daily diet for arduous work is decidedly the best. It is 26·7 ounces of water-free food, to which may be added 120 ounces of water. The whole yields 380 grains of nitrogen and 5,000 grains of carbon, or about $2\frac{1}{2}$ grains of the former, 35 grains of the latter, and five-sixths of an ounce of water for every pound of the body's weight.

The dry constituents are :—

Albuminous	6 oz.
Saccharine	16 „
Fatty	3·5 „
Salts	1·2 „
Water-free food	26·7 „

The admirable dietaries arranged by Dr. Parkes for war time, and Dr. Smith for laborious work, will furnish the above water-free food :—

Dr. Parkes.		Dr. Smith.	
Fresh boneless meat ...	16 oz.	Cooked meat	8 oz.
Bread	20 „	Bread	20 „
Potatoes and green vegetables	16 „	Potatoes and green vegetables	16 „
Peas or beans	3 „	Bacon, 4 oz.; butter, 2 oz.	6 „
Cheese	2 „	Cheese, 2 oz.; eggs, 4 oz.	6 „
Tea, coffee, pepper, salt ...	2 „	Tea, coffee, pepper, salt...	2 „
Sugar	2 „	Sugar	2 „
	61 „		60 „

Dr. Parkes gives in addition a pint of beer or half a pint of red wine, and Dr. Smith a pint of milk.

The following examples of diet used during periods of severe exertion possess some interest. In the reign of Edward VI., the rations allowed to English soldiers upon active service were two pounds of meat, one pound of bread, and one pint of wine. The same allowance of food served Dr. Livingstone's men very well on an expedition into the interior of Africa. Again, in one of the Kaffir wars, 200 men marched with no bad results

1,000 miles at the rate of 15 miles a day, and their diet consisted of one and a half pounds of solid food (biscuit and meat), supplemented by what game they could shoot upon the march.

Diet for obesity.

Many people appear to easily digest and assimilate the fatty and saccharine particles of food; and, as mentioned before, there is a strong presumption that such eupeptic powers, favour a deposit of fat both beneath the skin and between the muscle fibres. The storing up of adipose tissue is also promoted by such agents as diminished exercise, too much sleep, alcohol, coffee to some extent, and lastly an imperfect supply of oxygen to the blood.

Athletes, who have a tendency towards obesity, should therefore, in addition to their usual exercise in the open air, avoid or partake sparingly of the following substances :—Fat, cream, butter, cocoa, milk, sugar, parsnips, potatoes, beet root, farinaceous food, coffee, malt liquors, sweet wines and spirit.

They may take lean meat (not pork), poultry (not ducks or geese), fish, game, skimmed milk, Dutch cheese, oatmeal biscuits, salads, spinach, beans, apples, brown bread, tea, claret, and dry sherry.

Digestion.

A chapter upon the nutrition and the diet of human beings would be incomplete, if no notice were taken of one most important function of the body, namely—digestion.

Perfect mastication is the first step towards good digestion. The crushed and finely divided particles of food, especially the starch granules, expose thereby a much larger surface to the action of the various secretions of the alimentary canal. Moreover, the continual movement of the jaws stimulates the salivary glands to pour out their contents, and as the saliva is greatly concerned in the conversion of starch into sugar, it may be accepted as a truism, that "men with defective teeth are ill-qualified to become vegetarians."

Our forefathers, we know, recommended society at meals. The advice is sound; for company implies conversation, and its benefit upon the digestion is a two-fold one. First the motion of the jaws causes a fuller flow of saliva; and secondly the interchange of pleasurable ideas makes the heart contract more firmly, and so gives an impetus to the circulation of blood through the walls of the stomach. The result of this stimulation is, that the latter organ acts more powerfully upon its contents, and its glands secrete their juices more freely.

Although vegetables are not highly nutritious, they should always form a portion of the meal, the insoluble percentage of which, however carefully it be chosen, usually amounts to about one-fifteenth to one-tenth. This mass acts as a sponge, that soaks up the refuse of the now inert digestive fluids, and, by its bulk, stimulates the muscular coats of the bowels to contract and thereby to favour its expulsion. When, through the absence of vegetables, the food is more concentrated, there is a marked decrease in the quantity of the excrementitious matters, so much so that an erroneous idea of constipation is often entertained. Many things retard digestion, but I will content myself with drawing attention to two common and not often recognized evils :—the ingestion with the meal of very cold, or very hot fluids. The former seriously disorders the digestive organs, paralyzing them for a time, and checks the discharge of their secretions. It was found by experiment, that four ounces of water at 50° Fahrenheit reduced the normal temperature of the stomach for fully half an hour. How unphilosophical is the latter practice will be apparent when the physiological fact is known, that if the heat of the stomach rises to only 100° Fahrenheit, the gastric juices decompose, and lose their power of dissolving meat fibre.

Food takes three and a half hours to traverse the stomach, two and a half hours the small intestines, and twenty-four the whole length of the alimentary canal. The best indications of a well chosen, temperate and thoroughly digested meal, are the readiness to converse and to work immediately it is concluded.

CHAPTER V.

THE MUSCULAR SYSTEM.

Muscular tissue.

In all warm-blooded animals, "muscle" forms that part commonly known as "flesh." It is readily distinguished by its bulk, red colour, and peculiar granulated or striped surface; an appearance given to it by the longitudinal arrangement of bundles of muscular fibres.

Functions of Muscle.

Manifold are the duties performed in the vital economy by this willing and obedient slave. It inflates the lungs, allowing the air to fill their recesses; propels the food from one extremity of the alimentary canal to the other; drives the blood to the remotest portion of the body, and not only moves each and every segment of the limbs, but transports the individual from one place to another. Nor does the list of its functions end here. Within the quivering mass, which forms six pounds out of every stone weight of the healthy adult, occur those subtle chemical and vital changes that convert the inanimate nutriment, derived from the daily meal, into living flesh and blood; and those equally important ones by which mechanical energy is released. At the same time, the dying and decaying particles of the frame are reduced to such a condition of solubility as to permit the blood-stream to bear them to the skin, lungs and kidneys, for speedy removal.

Percentage of Muscular tissue.

The proportion of this tissue, to which the athlete owes in a great measure his prowess, largely exceeds that of either bone fat or nerve, and, as naturally would be supposed, varies at different periods of life. In the

infant, when the powers of movement and locomotion are feeble, it falls as low as twenty-three per cent. of the body's weight; while in the mature adult, who has attained his maximum degree of vigour, it rises to nearly forty-two per cent. Apart from the special purpose of this work, chiefly concerned with muscle as a source of mechanical energy, it should be obvious to every thinking man that a tissue, which forms so much of his weight and possesses so many and diverse functions, must vastly contribute to the comfort, the well-being and the maintenance of his existence.

But, before describing its properties and the interesting changes taking place within its interior during rest and during labour, let me draw attention to its two varieties —the voluntary and the involuntary.

Voluntary Muscle.

The term "voluntary" implies that the will has power to control the action of certain muscles which form the fleshy substance of the limbs, trunk and head, and that is, to some extent, correct. The muscles of respiration are, however, removed from the sway of the will, no effort of which can hinder them from inflating the lungs when the need for breathing has reached the well-known point of distress. Again, man is powerless, except in moments of intense emotional excitement (such as delirium fear or emulation produce) to call forth their whole energy. How great this is, the superhuman strength of the feverish woman, the terrible vigour of the madman, and the desperate struggles near the winning post, can best testify.

A good example of a voluntary muscle is the "biceps" of the arm. When the fingers touch the shoulders, it will be recognized gliding beneath the skin to form a semi-round, hard protuberance, and if the cutaneous covering were removed the mass would present the above-mentioned fleshy appearance, and, in addition, would be

found attached to the neighbouring bones by narrow silvery bands of great strength, termed "tendons."*

The involuntary variety better deserves its name, for the mechanism of the brain, which presides over its movement, is closely associated with the so-called functions of organic life—namely, respiration circulation and nutrition—and is quite beyond the control of the will. The provision is a wise one, for man is thus prevented from jeopardizing his existence by yielding to insane impulses and desires which might interfere with the action of his lungs or heart, or with the nutrition of his body. Involuntary.

In structure, in colour, and in mode of disposition, this kind differs from the voluntary one, for the fibres are of a paler red, and disposed in flat bands within the coats of the blood-vessels, and hollow viscera like the stomach and intestines. The heart-muscle appears to be the connecting link between both, resembling the one under consideration in being removed from the dictates of the will, but more allied to the other by its structure.

All living healthy muscle has two very remarkable properties, rightly called vital ones. They are the "property of contraction" and "muscular sense." Properties of Muscle.

Contraction of the fibres causes them to shorten their length, and this shortening, by bringing parts of the body into closer proximity, enables movements to take place and work to be done. It is, therefore, the property which is the source of mechanical force, and which has given to muscles the name of "work organs." There are two kinds of contraction, "simple" and "complex." The first, as in standing erect, and also in holding a Vital.

* A tendon blends with the muscle at one extremity and is inserted at the other into bone. Beneath the skin of the back of the hand, those of the muscles which move the fingers can be both plainly discerned and felt.

heavy weight, throws but little strain upon either the circulation or the respiration; whereas the latter, as in walking and running, stimulates powerfully the heart and lungs, and causes the muscles to expend a larger amount of heat, and of their especial energy.

Now before work can be started in any animate or inanimate mechanism, its essential parts must be in an effective condition, and a stimulation or releasing power be applied. This condition of healthy muscle is termed its "sensitiveness" or "irritability," and the releasing power is stimulation of different degree and value. Instances of this releasing power are the simple desire to move a limb, the more occult dictates of that part of the brain which presides over organic life, and currents of electricity passing along the muscle or along the nerve leading to it. At the commencement of any exertion this readiness to respond to stimulation is at its highest degree, and, while work proceeds, there is a sensible falling off. At length a time arrives when the exhausted fibres lose their irritability, and the most powerful stimulation fails to make them contract. Long before this period is reached, a feeling of fatigue warns the individual to cease from further efforts, and to seek the proper agents for restoring the tired muscle to a healthy state. Such agents are rest fresh air and food.

In health the fibres are always slightly contracted. This condition, which is known as "muscular tone," enables the braced-up muscle, so to speak, to respond quickly to the dictates of the will.

"Muscular sense," like the organic sensation of fatigue with which it is often confounded, appears to be located in the voluntary muscles. Although not reaching to the level of the sense of sight, hearing, touch, taste, or smell, it has not inaptly been called "the sixth one." It varies in acuteness, according to its degree of cultivation

and the occupation of the individual, but most people, by its aid, can discriminate, within an ounce, between substances ranging from three to four pounds in weight. Men who possess great manual dexterity, as musicians, billiard players, etc., depend largely upon the marvellous development of this sense for the delicacy and precision of their movements.

Two other properties, called physical ones, in contra-distinction to the above, deserve a short notice. The first is "elasticity," the well-known attribute of so many material substances: the second is a peculiar physical change which takes place in exhausted and dying muscular fibre, termed "Rigor mortis, or death stiffening." Physical.

When life has departed, the muscles of the body do not for hours, sometimes for days, lose their irritability; and the least stimulation will often produce, as seen in those who have died of cholera, movements of the limbs and trunk. After a longer or shorter interval, however, according to the circumstances which preceded dissolution, the fibres become opaque and of an acid reaction,* then stiffen, and finally contract. The muscle may now be said to die, for no response follows any further stimulation. The subsequent changes in the tissue are of the nature of putrefaction. It is important to bear in mind that after extreme exertion every muscle, and more especially the heart, undergoes a change closely resembling rigor mortis, as some of its fibres become opaque, and more or less rigid. Naturally this condition is one of danger to the integrity of the organ, but absolute rest and stimulating food will, as a rule, restore the tone. When these remedies are neglected, and further exertion persisted in,

* If red litmus paper be applied to a muscle at rest, the colour of the paper turns to blue; this is called an alkaline reaction. On the contrary, if the blue paper be applied to muscle while at work, or while in a state of death-stiffening, the colour is changed to red—an acid reaction.

some of the fibres are as completely destroyed as if death had occurred. To this cause may be attributed many of the diseases of the heart and large vessels which no inconsiderable percentage of athletes suffer from in later years of their life.

Muscular energy.

Although within the last fifty years the sciences of anatomy and physiology have made great strides, and illuminated many obscure corners of animal life, there yet remains to be revealed the source and mode of production of muscular energy. The nutrition of muscle, both at rest and at work, has been closely studied, and enough has been discovered to warrant the following theory. "Every fibre contains within its structure 'an energy producing material,' composed of the two elements nitrogen and carbon. While the muscle is quiescent, this remains almost intact, but when the organ becomes active, oxygen enters its substance in large quantities, and decomposes the material, leaving behind some of the nitrogen, but uniting eagerly with all the carbon to form products, the chief of which are carbonic acid gas and urea. In this decomposition or splitting up, muscular energy is released."

This action bears a close resemblance to that which chemists term "oxidation,"* and, while the blood supplies the oxygen, and the muscle fibre the material, energy is produced. When there is a failure in one or both of these conditions exhaustion results.

Repair of Muscle.

Intervals of rest allow the wearied heart and respiratory muscles to regain their wonted vigour, and thereby to propel a fuller and more nourishing blood stream to the exhausted frame. A double benefit results: the blood

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* Whenever oxygen unites outside the body with another element the chemical action is called "combustion or oxidation," and is attended with a rise in temperature and the formation of acid compounds. Now both these phenomena occur when muscles contract.

brings a fresh supply of oxygen and nutriment, and while the first reduces the products of previous action which encumber the tissues to a state of solution, the latter unites with the discarded nitrogen to form anew within the structure of the fibres "the energy-producing material." When both these changes have been effected the muscle regains its tone, alkaline reaction, and power of contraction.

This form of vital force attains its maximum amount at the period of life when the muscles have reached their maturity—namely, from thirty to thirty-five. After that time, with a sensible wasting of the organs themselves, there is a proportionate decrease in the energy they can evolve. To use an expressive phrase of athletes, "the muscles grow stale." Objection may be taken to this statement, and, without doubt, instances will be called to mind of men who have accomplished severe tasks, and acquired renown in the world of sport long after reaching thirty-five. But these cases of exceptional virility are few, and before my remarks can be disproved, it must be shown that such elderly athletes would not have gained even greater laurels at an earlier lustrum of their life, or that they have not acquired distinction at the cost of a damaged constitution.

The muscular energy developed within the body is not all exhibited as mechanical force, for one-third becomes converted into heat by the friction of the bones within their joints, and the tendons within their grooves.

Repair of the Heart and Respiratory Muscles.

The movements of the heart and the walls of the chest, although they slacken during sleep, never, as it is well known, absolutely cease; and the query arises, how is the wear and tear of these muscles made good?

The answer to this question is, that there exists undoubtedly within these structures a provision, whereby restoration of the fibres and renewal of vigour are

brought about with exceptional speed during that brief period of repose which occurs between each contraction. What this provision may be it is impossible to say.

Strength and development of Muscular tissue.

The foregoing naturally leads up to the consideration of the strength and the development of muscular tissue. In an average healthy adult one square inch of the muscles of the arm possesses power equivalent to 94½ lbs., and an equal proportion of those of the leg to 110 lbs. Hence one may readily believe that a strong man can lift 300 lbs. with his jaws, and 800 lbs. with his hands.

Exercise will always develop the bulk and vigour of muscles, and in many individuals to an extraordinary extent. A hereditary tendency has something to do with this, for such favoured men are, in the majority of cases, descended from muscular progenitors.

Endurance of toil and exposure.

Endurance of toil and privation is, however, a quality not entirely identical with mere brute strength. It is largely an attribute of the mind, in which courage or pluck is concerned ; and it is by no means uncommon to find this power of withstanding the injurious effects of exposure and labour possessed not only by small and feeble men, but even by frail and delicate women. Both endurance and muscular energy vary according to the climate and season, and in this country are at their highest about the early spring, a time most suitable, therefore, for severe athletic feats. They decline continuously throughout the summer months, and reach their lowest ebb at the beginning of the autumn. Men living in the tropics fully recognize the falling off in their vigour and endurance, and their lessened capacity for physical and mental exertion.

Development of special Muscles.

To develop individual sets of muscles, it is necessary to select the forms of exercise which will achieve the best results, and the following are recommended :—

For development of the muscles of the arms legs chest and back	Rowing, football.
Of the right arm and lower limbs	Fencing, cricket, skittles, bowls and quoits.
Of the lower limbs ...	Walking, leaping, running, racquet, fives, tennis and lacrosse.
Of the arms and chest ...	Gymnastic exercises:—as dumb bells, Indian clubs, vaulting horse, horizontal bar, swinging with the hands, trapeze, climbing ropes and ladders.

I have already hinted how gravely over-exertion of the muscles interferes with the production of their energy, and will deal more minutely in a future chapter with its injurious effects upon the chief organs of the body. This, however, is not an unsuitable place to discuss that natural monitor of the system—located by our mind in the muscles themselves—the "Sense of Fatigue." The sense of fatigue.

This sense should never be disregarded, for long before it apprises us of the exhaustion of the muscles, there has been a large dissipation of nerve energy, and with this a corresponding weariness of the brain and spinal cord. In a word, nervous and muscular force are invariably expended at the same time, but a more intense exhaustion of the nervous system precedes that of the muscles. The reader is acquainted with the symptoms of fatigue and the best methods of restoring vigour to the muscular organs. He may be sure that as they return to a healthy condition, so will there be a like recovery of nerve tone.

It is at this period of fatigue and weariness that alcohol, judiciously given, maintains the flagging powers, until more substantial food can be digested. The best

form of administrating this valuable nutriment is to dilute it with twice or thrice its bulk of milk, or with an effervescing water, and, where the stomach will tolerate the mixture, to add the yelk of an egg and sugar.

Injury to Muscles.

Every portion of our frame is liable to injury. To this rule, the muscles and their tendons form no exception: indeed, the athlete is more prone than the ordinary individual to contract rheumatism of, or to over-exert, these structures.

Any organ, busily discharging its function, contains an unusual supply of blood, and hence an active muscle is of a higher temperature than a quiescent one. For this reason the athlete should, after exertion, protect his heated body from the injurious action of cold and damp draughts by donning mufflers and flannel jacket, and by seeking the shelter of a warm room.

Rheumatism.

"Muscular Rheumatism" produces great tenderness on pressure of, and much pain in moving, the affected part; and, if the respiratory muscles be the seat of trouble, marked difficulty of breathing as well. Even when absolute rest is taken, spasms of a distressing character frequently occur. After the subsidence of the pain the enforced idleness causes much stiffness, a symptom that may last a considerable period. The muscles most often the seat of this complaint are those of the neck chest and back. The treatment is a warm bath, and wrapping the injured muscles in flannels wrung out in hot water, or applying to them hot bran poultices. When the pain becomes less acute, bandaging the part with a dry flannel roller, and resting it in a sling or on a well padded splint, afford much relief. The stiffness and loss of power that remains can be remedied by gentle friction with a stimulating liniment, by mild currents of electricity, and by graduated movements of the limb.

Over-exertion.

Over-exertion of the muscle is generally associated

with strain of its tendon. The pain differs from that of rheumatism in being, not so much spasmodic as dull wearying or burning; it is also felt most where the tendon is inserted into the bone. When the exertion has been unusually severe, there is, in addition, great swelling and a feeling of tension and creaking. The pain following excessive laughter, and the catch in the side so well-known to all athletes, are good instances of over-exertion.

The muscles most commonly affected are those of respiration, of the shoulder, the loins, and, lastly, the limbs. The treatment is almost identical with that already described for rheumatism.

Rupture of Muscle, &c.

Other more rare injuries of muscles and their tendons are rupture, either of some of the fibres or of the whole substance, and separation of their attachments from the bone. In the latter case, if the man has an exceptional physique, a portion of the bone may be broken off as well. Rupture of the muscle generally occurs in individuals of feeble strength, who have unwisely attempted some severe effort. All these cases need the immediate attention of a surgeon.

Effects of diet on Nervo-muscular energy.

I have deemed this portion of the book the most suitable one for discussing the relative merits of a mixed and of a purely vegetable diet, so far as they concern the repair of muscular tissue, and the generation of nervo-muscular energy. It has been conclusively shown that albumen, whether derived from a vegetable or from an animal source, is not solely necessary for the production of mechanical force, although absolutely needed for the repair and nourishment of muscle fibre. It has, likewise, been pointed out that, although the loss of nitrogen from the body is larger when much exertion is made, the increased waste of this element is neither proportional to the labour done, nor influenced greatly by the diet.

Again, whatever the source of this loss of nitrogen may be, it does not originate, as was formerly supposed, entirely from the destruction of muscular tissue. From the above conclusions, a diet of cereals, vegetables, together with other saccharine substances and fat, alone or combined, should save, to a great extent, the ordinary daily wear and tear of the nervous and muscular systems, and should enable a man easily to perform a fair amount of mental and bodily labour. In practice, however, such a diet, especially if the cereals be omitted, or only those used which contain a small percentage of nitrogen, is not favourable to a high degree of mental and physical development. And the races of mankind or individuals who subsist on so restricted a diet are characterized by a low production of nervo-muscular force, by feebleness, and by timidity.

Undoubtedly there are exceptions to the above, and many of my readers will think of the hill tribes of India, who live on rice; the natives of the Appenines, whose principal food is chestnuts; and the Arabs of the Soudan, who depend for their support upon dates—all of whom are noted for fine physical development and great strength. It must be remembered that these men have inherited exceptional digestive powers and a fine muscular system through long lines of ancestors, who, like themselves, lived a primitive and active existence in a pure atmosphere—conditions that do not obtain in this country. Now, on the contrary, a diet which contains all four of the constituents of human food, the albuminous one being well represented by such articles as meat, fish, eggs and cheese, harmonizes better than any other with the plan and construction of our digestive organs; and man, on such a combination of nutriment, attains the most vigorous development of brain and muscle, and produces the maximum amount of nervo-muscular force.

Exercise, undoubtedly, deteriorates nerve and muscle fibre; and if animal food does not directly replace the energy-producing material which is consumed, it certainly promotes, better than any other nutriment, its fresh formation. In addition, animal food greatly assists in restoring to the blood its solid particles, particularly the red cells, and it likewise renders all the organs of the body firmer. When men work hard, and especially in inclement seasons or in cold climates, the desire for animal food is an imperative one, and if not satisfied, the amount of labour performed falls off. This fact was noticed in the Crimean war. As soon as the French navvies were allowed the same quantity of meat as their English fellow-workers, they were able to accomplish a similar amount of work. Individuals, and races of men, who by preference choose a diet containing much animal food, have, usually, the finest physiques and the highest mental qualities, and throughout the world are noted for their enterprise, their scorn of danger, and their powers of endurance.

In conclusion, I may add that some animals evince a marked change of disposition in accordance with alteration in their food: for instance, a bear when fed on buns grew gentle and tame, but as soon as flesh was substituted it became very fierce and unmanageable.

CHAPTER VI.

EXERCISE AND REST.

Exercise and Rest.

Exercise and rest are daily recurring imperative wants of the human body, and, if not attended to, cause a marked disturbance of the health.

At the commencement and termination of life, rest is the more pressing of the two; consequently we find infants and old people passing many hours out of the twenty-four either in repose or in sleep. Indeed, with the aged, the need of it becomes, each day, more and more urgent, until death—that complete rest—closes the scene.

I propose in this chapter to point out the effects produced by both agents upon the vital economy; and will endeavour to show how, when judiciously attended to, they become instruments for good; and how, when neglected, or indulged in to excess, the constitution suffers.

Exercise.

Exercise proclaims its demands at a very early stage of the child's muscular development, and these steadily increase up to the age of puberty. The ceaseless movements of the limbs in infants, and the superabundant energy of young boys and girls, manifested by exaggerated and purposeless muscular action, plainly indicate the intense delight derived from the satisfaction of this want.

How seriously residence in large towns and the needs of commerce interfere with the enjoyment of exercise have already been mentioned; it were well, if the State would, in the present age, help to remedy such undermining of the public health.

Our forefathers had more regard for the physical culture of the rising generation. One finds enacted in the early statute books that all schoolmasters should teach their pupils the use of the bow and arrow; and each parish be assessed to meet the expense of providing these weapons.

The Greeks, when their cities grew beyond a certain size, and the Romans, from the early days of the Republic, established public games, and encouraged athletic sports in the interest of their youth.

Its effect upon nutrition.

Exercise, there is ample evidence to prove, is Nature's stimulant for the promotion of the proper nutrition of our frames; and of the five animal appetites it is, probably, the one most concerned in assuring a high degree of vigour and a good standard of physique.

This is exemplified in the robust condition of the working class of all civilized countries, despite the adverse circumstances of short hours of repose, and of a scant and inferior food supply.

By its agency the blood is rendered purer and richer, and is driven in a fuller stream to each and every portion of the body, awakening all the organs to new life and redoubled energy. Under the same influence the skin, kidneys and liver show unwonted activity—an activity demonstrated by the large increase in the solid constituents of the sweat and urine, by the freer escape of these secretions from the system, and by the maintenance, independently of season, of a more equable bodily temperature.

Sufficient has already been said of the increased growth repair and action of the muscles brought about by exercise. I will now describe the equally important improvements wrought by its aid, in the functions of digestion, innervation, circulation and respiration.

Upon digestion.

Whenever exercise is taken in the open air the diges-

tive powers, if previously sluggish and feeble, become more rapid and vigorous. The appetite is keener, the desire for albuminous and fatty food greater, and the larger meal is not followed by any feeling of discomfort. Indeed, in certain intractable forms of dyspepsia, this stimulus to the digestive organs will effect a cure, when every other mode of treatment has failed. Assimilation of the food is likewise benefited, for, although the production of energy is now greater, the waste products of the body—(judging by the amount of fæces)—are proportionately smaller than when the man is resting.

Upon innervation.

The brain and spinal cord speedily reflect their improved tone in the cheerfulness, freshness and mental elasticity of the individual, in his willingness to face danger or exposure, and in the diminished sexual desire.*

I may here allude to the oft-repeated assertion, that "athletes are wanting in mental acumen and in intellectual culture." As a matter of fact, it may be conceded, that, in this respect, they do compare unfavourably with other men ; but I cannot, therefore, accept the conclusion, that exercise deteriorates the higher functions of the mind. The deficiency more probably arises from the mere neglect of mental studies. Competition in all forms of athleticism is, at the present time, so severe that a young man dares not hope to achieve distinction in his favourite sport unless he devotes to it the whole of his leisure. An attention so exacting, consequently, allows him few opportunities of cultivating a brain, which is in a far healthier condition than that of the pale-faced student who despises muscular exertion in every shape and form.

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* This latter want is, probably, lessened by the diversion of nerve force into other channels.

When the exercise is moderate the circulation throughout the body is greatly accelerated, and although the heart's pulsations rise 10 to 30 per minute they remain forcible, regular, and equal. The pressure of the blood now becomes considerable within the vessels, the elastic and muscular coats of which, as my reader is aware, expand to admit this increase to their contents. This expansion, as well as the fuller action of the lungs, prevents any feeling of painful throbbing, suffocative breathing, or oppression about the chest, which the rapid pulsation of the heart would otherwise cause. Upon the circulation.

One other result of the increased pressure within the vessels deserves notice. The nutrient particles of the blood escape more readily into the surrounding tissues, and more effectually nourish them.

Respiration is profoundly affected by exercise, for, apart from the pleasurable excitement of emulation and of taking part in a favourite pursuit, the walls of the chest move more freely, and the blood circulates through the air cells of the lungs with greater rapidity. This combined stimulation ensures a ready admission of oxygen to the blood, and a more thorough removal from it of carbonic acid gas. Upon the respiration.

Indeed, from the amount of the former gas inhaled during various forms of movement, in a given time, Dr. Smith has drawn up a table of the comparative influence of different exercises upon the function of respiration. He took, as his unit of comparison, the volume of air a man inspires when lying down.

Dr. Smith's Table of Inspiration.

Reclining	1 volume.
Sitting	1·18 volumes.
Standing	1·23 ,,
Riding (trotting)	4· ,,
Swimming	4·3 ,,
Walking (four miles an hour)	5· ,,
,, (six miles an hour)	7· ,,

Over-stimulation of the Respiratory organs.

Although there are other and totally distinct causes of embarrassed breathing, this disturbance of the respiratory function usually results from overstimulation of the lungs.

"Rowing," of all the sports, considering the great muscular vigour it promotes, sins in this respect the least. As a matter of fact, a long slow stroke hardly disturbs the normal ratio of the respirations. The inspirations are in direct proportion to the quickness of the stroke: thus in paddling they are 28 per minute, and in racing as high as 40.

The way in which the lungs adapt their action to this exercise can be easily followed. While a man is reaching forward in the boat he expands his chest, and, at the commencement of the stroke, has fully inflated his lungs; this is the moment of the greatest muscular effort. As he stretches backwards the effort wanes, and the air slowly escapes in a prolonged expiration; so that, by the time the pull is concluded, the lungs are empty and the muscular exertion ended.

"Running," on the other hand, is a fruitful source of overstimulation. For this reason the trainer on the first day of the preparation should count the number of respirations per minute, after he has indulged his pupils in a sprint of 200 yards. Each succeeding day, at the end of a similar race, the number should decrease; if it does not, the athlete is taking too great an amount of exercise.

Other causes of shortness of breath.

Embarrassed breathing, or shortness of breath, occurs at different periods of the training from other causes. At the commencement of the course, it has been ascribed to "internal fat." No such deposit is to be found around the viscera of young men; and even, if it existed there, the means adopted by the trainer for its removal—as purging, low diet, and abstinence from certain foods—

are useless. The disturbance really arises from the unwonted activity of the muscles, which suddenly drive into the chest a large quantity of blood that has previously been stagnating in the veins.

The heart, lungs, and large vessels of the thorax are not prepared to receive this influx: they become congested, and their functions deranged. The proper remedy is a better regulation of the exercise. The number of respirations, and of the heart's pulsations, per minute, are thereby limited, and time is given to the vessels for the accommodatory expansion. When the latter has taken place the distressing symptoms speedily subside.

It recurs, however, at a later period, but then from an entirely different cause. In ordinary life the breathing is uniformly shallow, and rarely is the chest thoroughly expanded. But exercise, by producing deeper respirations, tax considerably the muscles of the thoracic walls and the diaphragm. The flabby and relaxed fibres, unused to such exertion, are thrown into a state of painful spasm—the well-known stitch in the side; at the same time the breathing becomes very short and intensely painful. Rest, gentle friction to the side, and a draught containing ether and belladonna relieve this trouble. A recurrence is prevented by a wiser graduation of the daily work.

Towards the conclusion of the training difficult breathing often occurs. It usually proceeds from distension of the stomach and bowels, by the gases given off through the decomposition of food, or of retained fæces.

These gases, by inflating the abdomen, push up the diaphragm or midriff into the cavity of the chest, and so seriously diminish its ordinary dimensions. The lungs and heart have, therefore, not their accustomed space to work in, and their action becomes impeded. In nine cases out of ten, the impaired digestion proceeds

from exercise, either too severe or taken too soon after a meal. It can be obviated by the substitution of a lighter diet, by giving stimulants with the food, and by enforcing more rest. The constipation is best treated by a brisk purgative.

Neglect of exercise.

When exercise is systematically neglected, unmistakable signs of failing nutrition appear, the chief of which are a toneless condition of the nervo-muscular system, a lessened production of energy, and the accumulation of fat beneath the skin and between the fibres of the muscles. The latter organs become soft and incapable of much exertion, while the nervous system is over-sensitive, easily disturbed, and very soon exhausted. A languid circulation and an insufficient supply of oxygen to the tissue, account for the deposition of fat, which, in extreme cases, converts some of the muscular fibres into adipose tissue.* As a rule, the resumption of exercise promotes a more healthy nutrition. The superabundant fat cells disappear, the muscles become firm and strong, and the brain more vigorous. If, however, the return be not a careful and a gradual one, irretrievable mischief may be done to the relaxed and feeble fibres, especially those of the heart. This fact should be borne in mind by young men, who, after leading an inactive life throughout the winter, are very apt, on the return of fine weather, to suddenly resume violent muscular exertions.

Sudden cessation of exercise.

Another evil, and one which athletes are prone to, is the sudden cessation of muscular work as soon as the period of training and competition is passed. Weeks of a healthy life in the open air have brought all their organs into a state of perfect functional activity, and created, not only the need for the stimulation of exercise, but also, with a keen appetite for animal food, a remark-

* That insidious and fatal disease, "fatty degeneration of the heart," is thought to originate in this way.

able power of assimilation. During the lazy existence which many of them lead in the dark days, these organs miss the accustomed stimulation, and plainly show their sense of neglect by an irregular and incomplete discharge of their functions. To add to the trouble, the desire for a large meat diet is often unchecked, although the athlete must be conscious of no longer requiring so much sustenance. Is it to be wondered at that the digestion soon becomes unequal to the demands thrown upon it, and that serious derangement of the stomach, liver, and kidneys follows? I have been impressed by the number of cases of indigestion, bilious attacks, gout, skin disease, and mental depression it has been my lot to treat in this class of patients. These ailments can, undoubtedly, be traced to this cause alone.

Evils of excessive exercise.

The constant neglect of every kind of muscular exertion is bad enough, but excessive and intermittent indulgence is still worse. The spirit of emulation, to which this excess is usually traceable, is perhaps inseparable from all sports. But if this feeling be not kept within proper bounds it becomes antagonistic to the higher motive of exercise—a motive which is not mere glory, but the attainment of a well-developed frame and a robust constitution. The desire to excel and to gain a transient notoriety, though honourable enough within limits, is too much encouraged by the great publicity which the press now gives to every department of athleticism. The result of this is to nullify, to a considerable extent, the beneficial effects on the public health of all forms of recreation. Thus, to gratify a miserable vanity and to achieve their cherished object, men strain every nerve and sinew, troubled by no scruple as to the mischief likely to ensue from such extreme and unwise exertions. Not all can win; and when in after years the flagging heart, the weakened blood-vessel, and other physical maladies, which

no skill can cure, daily remind the winner or loser of the fiercely-contested race, he will, when too late, admit "the paltry prize was hardly worth the cost."

Medical men may have to say, at no distant future, that our athletes, like those who centuries ago contended in the Olympian games, rarely reach old age. Ample evidence is forthcoming of the mischief wrought by badly-chosen and ill-regulated exercise, both in lads not out of their teens, and in men of mature age.

On inclement winter days, half grown youths, insufficiently clad, may be seen at the University towns busily engaged in College races; some of them rowing as many as five or six heats during the morning and afternoon. Such excessive labour does not promote vigour, nor ensure a good physique. On the contrary, it undermines the strength, and, just as the lad's position is on the bow or stroke hand of the boat, often permanently distorts the right or left side of the chest. One hears, too, of men of adult age in whom these violent struggles for mastery on the river, the racing track, or in the gymnasium are followed by disastrous consequences. After assiduous attention to studies, an undergraduate, without being trained, engages in a rowing competition, and the terrible exhaustion resulting ends in insanity; another has dangerous fainting fits; while a third suffers for a lengthened period from muscular paralysis. Other instances, too numerous to quote, of acute rheumatism, loss of mental and physical power, and heart disease, are directly traceable to the same cause.

The vital organs which suffer the most from the indiscretion under consideration are, as might be supposed, the muscles, the blood vessels, the lungs, and the heart.

On the muscle.

Muscular fibre, when the exercise has been excessive, undergoes a change which, if not identical with, closely

resembles that described as death-stiffening; and to the destruction and disappearance of this tissue one must look for the source of some portion of the unusual amount of nitrogen which escapes by the skin and kidneys during arduous labour.

Long before danger to the integrity of the muscle is threatened, ample warning has been given by the sensation of fatigue, and by tremors and twitchings of the fibres. These admonitions should not be slighted.

On the blood-vessels and brain.

The powerful muscular contractions drive the blood rapidly along the veins without injury to them; but, owing to the circulation through the heart and lungs being impeded, the pressure within the arteries reaches a dangerous limit.

Now, those of the brain, as they contain within their coats no muscular fibres, cannot accommodate their calibre to this increased volume of blood, and hence this pressure expends itself upon the delicate and highly sensitive nerve structures. A double evil may result—either a vessel gives way causing apoplexy, or some latent tendency to insanity or epilepsy becomes developed.

On the lungs and heart.

In the congested lung a rupture of an over-distended vessel is not unusual, the immediate consequence of which is profuse bleeding from the mouth, and a later one—consumption. In addition, the elastic walls of the air cells are at times stretched beyond the power of returning to their original size, for the pent-up air escapes very slowly during violent muscular efforts. This over-distension infallibly leads to permanent shortness of breath.

The immediate strain upon the heart is revealed by rapid, irregular, and intermittent palpitations, giddiness, indistinct vision, cold sweats, and faintness. Rupture or laceration of one of its valves may take place at the time, and enlargement of its walls with subsequent degeneration of their structure later on.

Members of the Alpine Club are well acquainted with the painful throbbing experienced on climbing ascents; a sensation produced by the impeded flow of blood through the congested walls of the heart.

The spurt. The above description of the evils of excessive exercise is a fitting prelude to what I have to say respecting the behaviour of the organs of the chest, during the continuation of that supreme effort known as "the spurt." A deep and prolonged breath, which distends the lungs to their very utmost, is first taken. Then the glottis or valve of the windpipe firmly closes the aperture above, the diaphragm strongly contracts below, while the rigid and unyielding walls of the chest forbid any further expansion. The pressure within the thorax upon the air cells, the interior of the blood vessels, and the cavities of the heart, now attains a portentous amount, and leads to serious obstruction of the circulation. This obstruction is clearly shown by the bloodshot eyes, and by the extreme distension of the veins of the face and neck, which stand out under the skin like blue cords. Now is the moment when any latent defect in the heart, lungs, and blood vessels will declare itself; or, if they be sound, any sign of an inefficient training. If, however, the constitution be sound, and the preparation satisfactory—notwithstanding that the heart is beating 170 times in a minute—the pulse will be regular and equable, and very little distress about the chest be felt. Such exertion, it need scarcely be said, must be counted in seconds. Presently the muscles slacken, the heart contracts slower and slower, the lungs relieve themselves by a prolonged audible expiration—almost a sigh—and the spurt comes to an end.

When, to use the sufferer's expression, "something goes," it is usually the laceration of the lung substance, a valve of the heart, the wall of a vessel, or the fibres of a muscle.

Great care is taken by the present military authorities to protect the recruit from the dangers of excessive exertion, and they deserve much commendation for the judicious way in which they preserve and develop the man's muscular powers without taxing unduly his constitution. After joining, he for three months undergoes, each day, three to four hours' ordinary drill, and one hour's work in the gymnasium; the latter exercise being superintended by a surgeon. This course is followed by six weeks' rifle drill; and, after another month of gymnastic preparation, he ranks as a trained soldier. Amount of exercise.

Professor Parkes calculates that a healthy adult should expend, every day, sufficient muscular energy to raise 150 tons one foot high, or to walk nine miles. Now the work done by an oarsman, in propelling an eight-oar boat one mile at racing speed, is equal to 18½ foot tons;* so it is easy to calculate from this the amount of exercise a candidate for rowing honours takes. A trainer must, in addition, closely watch the effects of exercise upon the health and energy of his pupil, and proportion the work to his powers of endurance.

The following is an instance of severe exercise unattended with bad results. The pedestrian, Weston, when 31 years old, and scaling 120 lbs., walked 310 miles in four consecutive days, and at the end of his labours had lost only 3½ lbs. Of this loss 3 lbs. was muscle substance, and the remainder fat and water. Within two days from the termination of his walk, he was within a quarter of a pound of his original weight.

It is difficult, if not unwise, to fix rigid rules of exercise; but I commend the following initial principles Principles of exercise.

* The Oxford men, while training for the Inter-University race, row twice every day to Iffley and back (3 miles), once during the week to Abingdon (7 miles), and once or twice a month to Wallingford (21 miles).

to the consideration of all who have the charge of preparing athletes for any form of sport.

Exercise should take place in the open air, or, when this is impossible, in a large well-ventilated room. There should be no hindrance, by tight clothing, to the fullest and deepest expansion of the chest walls, as this provides for the free entrance of oxygen to the lungs, and the equally free escape of carbonic acid gas. Laborious and sighing breathing, throbbing of the heart and vessels, unequal and intermittent pulse, are the symptoms that indicate the retention of the latter gas within the blood, and likewise a congested state of the lungs. When they occur in a slight degree, the exercise should be suspended for a quarter of an hour: but if they be severe it should be discontinued for the day. The hours for exercise should be regular; and in the summer, by proper arrangement of the meals, advantage taken of the cool air of the morning and evening. Half an hour's exertion before breakfast is ample. Digestion and assimilation of food are more vigorous in the early part of the day; it is, therefore, not advisable to exhaust the system by laborious work while the stomach is empty. A quarter of an hour's rest should be observed before sitting down to a meal, and, when it has been a hearty one, exercise should not be resumed for one hour and a half afterwards. The form of exercise should be varied as much as possible, for variety relieves the monotony of the preparation, keeps the man cheerful, and tends to a more thorough development of the muscles.

The work done daily must also be gradually increased: this, as so often insisted upon, gives the blood-vessels time to accommodate their size to the increased circulation through them, and enables the heart and lungs to regulate their action to the greater work of the muscles. The trainer should always bear in

mind that it is a bad policy to over-fatigue his pupils; he should stop most of the exercise two days before the competition, and at the same time allow an additional hour or two of sleep.

As the work becomes more severe, so should all the constituents of the food be increased—the albuminous and the oleaginous ones the most. The latter is needed to replace the large amount of carbon which disappears during muscular action in the form of carbonic acid gas. Neither ought the athlete's selection of diet be much interfered with. It rarely happens that the article desired is innutritious or indigestible, and, where the appetite is failing, such interference is harmful.

REST.

Rest, although in many respects a want of the body secondary to that just considered, deserves almost equal attention, for its neglect inevitably brings a train of serious troubles. Rest.

Sleep is the most pronounced form of rest, and when, from any cause, it has not been gratified, the craving becomes so intense that the strongest effort of the will, and the most powerful emotions—as of love and fear—are unable to withstand it. Indeed the exhausted man will slumber under such unfavourable conditions as while standing on sentry duty, or marching along a road.

The predisposing causes of sleep are heat, cold, the products in the air of the combustion of gas or coal, monotonous sounds, and fading light. The exciting ones are bodily and mental fatigue. How these causes act remains a matter of conjecture, and of the many theories suggested, the following two appear to me to claim precedence. The causes of sleep.

Every kind of exertion produces changes within the nervous and muscular organs closely resembling oxidation; the result of which is that the stored up oxygen within the blood and tissues disappears, to be replaced by carbonic acid gas. Therefore, each hour of active life is marked by the gradual dissipation of the one gas, and the slow accumulation of the other. When the latter has reached a certain degree, a feeling of weariness and a desire for sleep make themselves felt. What follows in the long hours of the night, provided the bedroom is a large and well ventilated one, is a reversal of the gaseous interchange—the oxygen once more accumulating in the body, and the carbonic acid gas to a great extent escaping. If nothing occur to mar this vital action, the man wakes in the morning with his mind cheerful and elastic, and his body reinvigorated. The writer cannot but think, that the accumulation of other waste products within the tissues during the day has something to do also with the desire for sleep; and he would draw attention, in support of his opinion, to the very concentrated state of the urine and sweat which are excreted during the night and in the early morning. The second theory, advanced by the late Dr. Moxon, is a most ingenious one, and if correct, as there is every reason to suppose it to be, shows a wise provision of nature to protect man from the injurious effects of over-exertion. He observed that, owing to the size of the vessels which pass to the lower extremity of the spinal cord, this portion of the body does not receive a supply of blood sufficient to nourish it, when man is in an erect position. Such a failure of nutrition to so important a part of the nervous system must, he concluded, after a certain time, the length of which would depend upon the vigour of the individual, originate sensations of fatigue intense enough to compel the man either to sit or to lie down.

Both the above theories are corroborated by the following facts :—the sense of exhaustion and the products of chemico-vital changes of the body reach their maximum amount between 10 and 11 p.m. ; the production of nervo-muscular energy is greatest on Monday (provided Sunday be a day of rest), and declines each day until Saturday, when it reaches its lowest point ; and, lastly, the capacity for exertion is most marked in the early morning, and falls hourly throughout the day.

So thoroughly are all the organs of the body rested during sleep, that conscious life may be said to end ; the pulsations of the heart and the movements of the lungs are so gentle as to be scarcely perceptible ; the walls of the stomach and intestines are quiescent ; and the nutritive changes in the remaining organs are probably limited to the removal of effete materials.

The need of rest, judging from the amount of sleep Amount. taken, appears to vary within wide limits in different people. The temperament of the individual, the season of the year, and the previous exertions are the chief factors which influence it. In hot weather less sleep is required ; and men of an excitable nature seem to be satisfied with shorter hours of repose than those of a lymphatic temperament. It is stated that John Hunter, the anatomist, and Frederick the Great, both men of exceptional mental and bodily vigour, habitually slept but five hours out of the twenty-four. As a general rule the amount of sleep necessary for a healthy adult is from six to eight hours. John Wesley's maxim upon this question is worth recording, it is "rise each day half an hour earlier until you find that you neither lie awake upon going to bed, nor wake up before your usual time for rising." The best time for retiring is about 11 p.m. ; and, in the summer months, 6 a.m. is a suitable hour for getting up. Every seventh day an extra hour's sleep may be taken with advantage.

Excessive rest.

Excessive rest interferes with the production of nervo-muscular energy. It does not recruit the wearied muscles, nor favour the restoration of a congested and exhausted brain to a healthy condition. In the latter case, exercise, by diverting the circulation towards the limbs, removes more efficiently and safely the headache, depression, and disinclination for food.

CHAPTER VII.

PERSONAL HYGIENE.

Under the heading of Personal Hygiene an attempt will be made to trace the influence upon health of certain minor and often neglected agents; such as baths, climate and temperature, clothing, the sanitation of bedroom and sitting room, and tobacco smoking.

Baths. Baths, whether they be in a gaseous or a liquid form, should be employed for the purpose of giving tone to the nervous system, for cleanliness, for the removal of fatigue, and for two other objects which do not come within the scope of this work, namely, swimming and the treatment of disease. When liquid, they are applied to the surface of the body by means of the sponge, the plunge, and the shower, or of some such modification of the last as the needle or douche.

The cold bath. Cold bathing is used for one object alone—to give tone to the nervous structures when these have become relaxed from sleep or from warmth. This action, although invigorating all the functions of the body, principally affects those of respiration and circulation. Under its benign influence a delicious sensation of freshness and energy is experienced, the intellect grows clearer, the breathing becomes deeper, the heart beats stronger, the temperature of the body rises slightly—owing to the stimulation to nutrition—and the skin is reddened with a characteristic glow. This ruddiness is due to a vigorous return of the blood into the cutaneous vessels which the first shock of the cold water has emptied. The reaction

should take place within three minutes of entering the bath.

Mode of bathing.

The temperature of the cold bath varies, according to the season of the year, from 32° F. to 70° F.; the degree of coldness best suited for this climate is, however, 50° F. The bath ought to be taken immediately on rising; its duration should not exceed three minutes in the winter; and, according to the power of bearing the shock, the plunge, shower or sponge should be selected. It is a wise precaution to douche the head before entering the bath, and to dry the skin thoroughly on leaving it. Where time admits, 5 to 10 minutes subsequent exercise with the dumb-bells or the Indian clubs maintains the stimulatory effects upon the circulation and respiration.

Contra-indications.

Only during the hot months of the year should delicate men with defective circulation have recourse to this restorative agent. At other times its action upon them is that of a powerful depressant to the nervous system: the skin exhibits no ruddiness—indeed the ears, nose, lips, hands and feet are blue and drawn—there is shivering, and with it a feeling of chilliness and lassitude which may last for hours. The redness produced by the friction of rough towels is often confounded by bathers with the healthy reactionary glow, and thus the injurious effects of this kind of bathing are often masked for a considerable time.

Athletes, after severe exercise when the skin is pale and chilly, make far too free a use of cold water. Previous sweating has reduced the body's warmth quite enough, and any further loss is undesirable. Besides, the application of cold at such a time retards, instead of promoting, the recovery of the tone of the enfeebled muscles.

The tepid bath.

The temperature of the tepid bath is from 70° to 90° F.; its particular purpose is "cleanliness." Upon

the central nervous organs and the functions of circulation and respiration it has no power either for good or for evil, but it does exert a mild tonic action upon the skin and muscles through the nerves terminating in these structures. In the form of a shower it rapidly equalizes the temperature of the body, causes the over-distended vessels of the dry and full-coloured skin to contract, and replaces the uncomfortable sensation of extreme warmth with the more delightful one of coolness. For this purpose alone all club rooms used by athletes should be provided with a shower-bath apparatus. Tepid bathing may be taken, without danger, at any period of life, both by the strong and the delicate; and a long immersion is not attended with the evil results that follow a similar use of cold or hot water.

The hot bath, the temperature of which ranges from 90° F. to 104° F., is a powerful agent for the removal of fatigue. Hunting men, who use it habitually, know this well, and can testify how, under its influence, the feeble and stiffened limbs soon become supple and strong. The ancient athlete resorted to the warm bath immediately on leaving the arena; and it is on record that the first Napoleon ascribed his wonderful powers of endurance to the practice of indulging in it, whenever possible, at the conclusion of his battles. Its action upon the functions of the brain, heart, and lungs is the reverse of a bracing one; and the sense of tranquillity and *bien aise* which attends its use, arises probably from the diversion of the blood current from the swollen vessels of these organs, especially of the brain, towards the skin and muscles. Undoubtedly it expands their vessels, checks the loss of heat, and, by promoting a larger supply of blood to them, favours a rapid combustion of the partially changed products of the previous muscular work, and also their speedy removal from the system. The hot bath.

The too frequent use of the warm bath, however, renders the skin and mucous membranes very sensitive to changes of the weather, and predisposes the individual to contract cold. Far more serious is its action of lowering the production of nervo-muscular energy, and the bather soon experiences a growing disinclination for muscular and mental labour. The duration of the bath should not exceed ten minutes, and, to lessen the predisposition to catarrh, should be followed by a tepid shower. The most important modifications of this form of bathing are the Turkish and the Russian baths, both of which act so powerfully upon the human economy as to deserve a separate notice.

The Russian or vapour bath.

The Russian or vapour bath may be briefly described as consisting of a chamber in which moist air is heated to 120° F. Evaporation of moisture from the skin and the lungs is greatly hindered, and this interference with an important function of the body causes the following symptoms :—a rapid and tumultuous pulse, palpitation of the heart, throbbing of the large blood vessels, painful constriction in the head, and an uncomfortable sensation of extreme heat ; the temperature, indeed, rising from 2 to 3 degrees. This distress lasts a longer or shorter time until sweating sets in, which may be so profuse as to cause the bather to lose in a quarter of an hour as much as three pounds in weight. If from any cause this "crisis" be delayed, serious mischief or even death may result from heat-stroke. The action of the Russian bath is decidedly depressing, and at its conclusion lassitude and exhaustion are experienced.

The Turkish bath.

The mode of bathing practised by Eastern races differs from the so-called Turkish bath of this country in the essential point that the temperature of the sweating chamber with them is never allowed to exceed 98° F., while in Great Britain it is 180° F., or even higher.

The Anglo-Turkish bath—to give it its proper designation—consists of a series of chambers communicating one with the other, and filled with dry air of different degrees of heat. The coolest, about 100° F., is reserved for shampooing, and has attached to it shower, plunge, and douche baths.

The bather enters in a nearly nude state the heated rooms, and remains there until the skin acts freely; then passes under the hands of the shampooer, and, after being well soaped and rubbed, finishes with a cold or tepid bath administered in one of the above forms. His body having been dried and swathed in towels, the bather now proceeds to a well ventilated, moderately heated chamber, the "cooling room," where, previous to dressing, he reclines for a short time on a couch.

Action of the bath.

Unlike vapour, heated dry air favours rather than impedes the evaporation of water from the skin and lungs; nevertheless, until free perspiration be excited the bather is troubled with symptoms which resemble in kind, if not in degree, those described under the Russian bath. The most pronounced of these are distressing pulsations of the heart and of the large blood vessels, and the intolerable feeling of heat.

The further action of the bath is to relieve the functions of the kidneys—lessening thereby the amount of the solid constituents of the urine—and to induce some slight constipation. The latter probably results from the deprivation of moisture, for so much water escapes from the tissues that a man may lose from 2½ to 3 pounds weight in an hour. After bathing there is a sense of lightness, elasticity and exhilaration; and even when the opposite condition, "exhaustion," follows it is never so profound as that produced by the vapour bath.

The advocates of the bath claim too much for it, and, forgetting its action upon the circulation, recommend its

use even to men in the extreme stages of heart and kidney disease. They assert that no agent can so safely and speedily remove the sense of fatigue, or the waste products of the body. Indeed, they affirm that by its use the sweat glands act so efficiently that the perspiration of constant bathers show on analysis no trace of saline and organic matters ; and they point triumphantly, but illogically, to the fact that the Eastern races never suffer with gout.

The opponents, with whom I to a certain extent agree, justly say it is not the true Turkish bath, and that, in this cold climate, the exposure of the body to such extremes of temperature in so short a space of time is unphilosophical and highly prejudicial to the equable performance of its many functions. All they are disposed to admit is that it may be serviceable at the changes of the seasons, more especially in the early spring, when the skin shows a deficient action, and the tissues are surcharged with moisture. I go a little further than this, for I believe that, by promoting the functions of the skin and lungs and lessening thereby the labours of the liver and kidneys, under certain restrictions the Turkish bath will always prove of great help to men free from organic disease. Athletes, as stated before, during the winter do neglect exercise and indulge to excess in sleep or food. The mischief to the health which attends these habits is materially diminished when this bath is taken weekly throughout this cold season of the year. The beneficial result of this treatment I have, again and again, seen in the disappearance of skin affections, the improved digestion, and the freedom from depression. On the other hand, it is a dangerous form of bathing for the pale, over-worked, and dyspeptic man. Whatever energy and endurance he still possesses becomes further reduced, and even if exhilaration follow the use of the

bath, it is a transient sensation, whilst that of the subsequent exhaustion is a most enduring one.

The rules I would suggest for the use of the Turkish bath are :—

1. Bathe two hours after a breakfast, and, before entering the bath, produce by a brisk walk a slight moisture on the skin.

2. Commence by wetting the head thoroughly with cold water; never enter a room heated above 130 degrees F., and be shampooed as soon as the perspiration flows freely.

3. Finish with a shower or douche, the heat of which is graduated, or, if able to withstand the shock, with a cold plunge. Dry well the surface of the body; then rest, and dress before chilliness is felt.

4. Do not let the duration of the bath exceed one hour; and use this form of bathing only in the winter and early spring at intervals of about seven days.

Before concluding the subject of bathing, let me caution my readers against that most pernicious method of reducing weight called "wasting," obtained, amongst other ways, by means of Russian and Turkish baths. This practice is used principally by jockeys, who, I presume, knowingly incur the grave risks to their constitution for the sake of the professional advantages that may ensue, but with athletes such considerations can have no place. To adopt such a measure in a system of training is most reprehensible, for it is diametrically opposed to the scientific and philosophical spirit of a judicious preparation, the object of which is "to conserve and not to dissipate vital energy." With each ounce of weight lost by such means there escapes an amount of both mental and bodily vigour difficult to estimate, and most difficult to replace. Wasting.

Naturalists have found by close observations that, of Climate.

all animals, man bears best the vicissitudes of climate; and of all races of men, one may confidently assert, those of Western Europe can endure the widest extremes of temperature. Yet the most favoured individual, in this respect, on exchanging the winter of England for the summer of India experiences some disturbance of his health. He is conscious of increased bodily heat, of a smaller production of nervo-muscular force, of a lessened appetite for animal food, and instinctively eats much fruit vegetables and cereals, and leads a more inactive life. In addition to the above easily recognized changes the skin perspires more freely, the respirations fall three to four per minute, and the blood is made less quickly, so that the face becomes pallid—a condition soon apparent in women who are more shielded from the sun's rays. The amount of water which escapes from the human body by the skin, rises 20 per cent., this causes congestion and obstruction of the sweat glands, and produces the irritable skin disease, termed "prickly heat."

Effects of high temperature.

Included in the effects of climate upon man must be the influence of a high or low atmospheric temperature. Warm air stimulates at first somewhat agreeably the nervous and muscular systems, raises slightly the animal heat, and, by enlarging the small cutaneous vessels, creates a pleasant sensation of warmth. Beyond this degree of stimulation mischief results, the severity of which will depend chiefly upon the amount of moisture present in the air. From the description of the Anglo-Turkish and Russian baths the reader knows that warm dry air at a temperature of 200 degrees F., provided the skin perspires well, can be borne with impunity; while on the other hand, when the atmosphere contains vapour, a heat above 120 degrees F. is prejudicial to life. In the latter case it is immaterial whether the man be in a vapour bath, under the shade of awnings, or within his

house. The symptoms of heat-stroke are almost identical with those brought about by exposure to the direct rays of the sun, and may be divided, for convenience of description, into premonitory and dangerous ones. The premonitory symptoms come on with slow breathing, rapid pulsations of the heart and vessels, and a painful increasing sensation of warmth : the temperature of the body is now two to three degrees F. higher, and usually the embarrassed system is relieved by profuse perspiration. All distress and oppression subside for a time, but with continued exposure to the heat the dangerous symptoms appear. These are briefly those already described, with the superaddition of dizziness, tendency to sleep, and partial or complete fainting. The following measures must be promptly taken. Remove the sufferer to a cooler atmosphere, free the upper part of his body from clothes, and douche repeatedly the head and spine with water as cold as can be obtained. When the power of swallowing returns, give him lukewarm water and sal volatile to drink, and later on strong coffee. Under this treatment recovery is often apparently complete, but, in many cases, subsequent failure of the mental vigour unmistakably show that either the brain or its covering has been permanently injured.

The conditions which lessen the ability to withstand exposure to dry and moist heat, are :—extreme youth or age, stout habit of the body, weak lung structure (emphysema), fatty degeneration of the heart, muscular exhaustion, any impediment to the movement of the chest walls, deprivation of water, and the consumption of a heavy meal or of alcohol. On the other hand, drinking tea or coffee increases the power of resistance.

Effects of low temperature.

Dry cold air is borne exceeding well by man ; it is a powerful stimulant to every organ of the body, and hence his mental and bodily vigour is greatest in the colder

months of the year. An extremely low temperature, however, especially if the air contains moisture, produces intense depression. The small blood vessels of the skin contract to their utmost, and divert the circulation to the internal organs, congesting them and interfering with the proper discharge of their functions. The body's warmth is lowered, a feeling of chilliness and torpidity of the brain ensue, and with it a distaste for mental or muscular exertion.

Clothes. Clothes play no unimportant part in the preservation of health, for they help to maintain the surface of the body at an equable temperature throughout all seasons, and shield the skin from many sources of irritation as friction and dirt. Their colour is not, unfortunately, sufficiently studied in this country either with regard to art or to health, and it should be better known that some hues reflect and radiate heat more than others. In this respect white sins the least, and hence is the most suitable colour for winter wear. Next to white comes grey, then yellow and pink, and last of all black. The material should be soft and pliable, and for underwear light, absorbent, and non-irritating. The shape ought neither to restrict the movements of the limbs and chest, nor expose them unduly to the heat or cold. Silk and a mixture of silk and cotton, make the best garments to be worn next the skin, but they have the disadvantages of being expensive and not readily cleaned. For these reasons cotton and linen are used as substitutes, and their ability to conduct heat away so freely renders them very agreeable and healthy for summer use. Cotton clothing is lighter, more pliable, and more wholesome than linen, but not so cool or so unirritating to the skin : the latter, however, causes greater chilliness when it becomes damp. Dr. Jaeger, a German manufacturer of woollen goods, has recently introduced a material for

underwear of the texture and consistency of the softest Jersey cloth. It appears to be a fine wool dressed in a special manner, and is an excellent non-conducting medium, unirritating, not heavy, easily washed, and much cheaper than silk. These properties render it a most suitable substance for zephyrs, drawers, and pyjamas. Wool and flannel, owing to their non-conducting and absorbent powers, make valuable under-clothing for the winter, when they can be tolerated next the skin; and are the more valuable if the individual takes much exercise and perspires freely.

Hygiene of the bed and sitting rooms.

When one remembers how large a portion of the twenty-four hours is passed in the bedroom, it is incumbent upon everyone to make the hygiene of his sleeping chamber as near perfection as possible. To avoid extreme heat and cold the room should have a west or south-west aspect, and a temperature which approaches the mean one of this climate, namely, 50° to 55° F. Its windows should be fitted with Venetian blinds: they are an admirable contrivance, and serve the purpose of excluding the glaring light of day, the moon rays of night, the summer heat, and the winter's draughts. The room can be kept cool in excessively hot weather by closing, in the early morning, the outer windows and lowering the blinds, keeping them thus fastened and shaded until the evening. Its cubic capacity should be 800 feet for each individual. The practice of sharing the same bed, or even the same room, with another person is an unsanitary one. At night time the windows should be lowered, and even in the winter not completely closed.

The material of the bedstead should be of iron—a substance easily cleansed—and this piece of furniture ought never to stand in a recess or against the wall. A mattress is preferable to a feather bed; it keeps the

brain and spinal cord cooler, makes the sleep more refreshing, and lessens the sensitiveness of the body to variations of the weather. Some consider the French "*sommier elastique*" less heating even than the mattress. A blanket and sheet to rest on, and the same for covering are ample as a rule, but on very cold nights an additional blanket can be used, or a light rug placed across the feet. Counterpanes are positively injurious: they add little to the warmth, and cause by their weight an excessive and weakening action of the skin. Pillows, if not too high, allow the blood to flow more readily to and from the vessels of the brain; the heart, thereby, beats more quietly, and the circulation is assisted. Bed-curtains are both effeminate and harmful, for they interfere with currents of air, and, by rendering the head and neck sensitive to draughts, predispose the individual to ear-ache, sore throat, and neuralgia. Other articles of furniture—save washing and dressing conveniences—as carpets, rugs, and bulky specimens of cabinet ware, are not wanted; they interfere with proper sanitation by diminishing the air space and by harbouring dust and the volatile exuviæ of the skin and lungs. Let me say a few words here about the night apparel—the outcome not of a superior hygiene but of a higher civilization. This may be regarded as a modern innovation, for one reads that until the 14th century the highest nobles in the land habitually slept in "the scandalous garb of the Greek slave." Pyjamas, so largely used by Englishmen abroad, are the most rational form of night dress. They protect the chest, allow perfect freedom to it and to the limbs, and maintain sufficient warmth even when the bedclothes become disarranged. For winter wear they should be made of a warm material, and Dr. Jaeger's cloth is the one best adapted for this purpose. Night-caps are fast going out of use, and rightly so: they

are extremely unhealthy, and a constant cause of neuralgia of the head.

The hygiene of rooms used for meals or for recreation claims but little attention. They should be chosen for the cheerfulness of their situation, well lighted, kept at a temperature throughout the year as near 60° F. as possible, and should be ventilated.*

Smoking.

Smoking is indulged in so widely, both by the young and the old, and in many cases with marked benefit to the mind and body, that it is an open question whether tobacco ought not to be included among the condiments. At all events, its action for good or for evil upon the human constitution deserves notice. Two principles, nicotine and nicotianine, can be obtained from the leaf in the form of volatile colourless bodies of a pungent odour and taste. The first is a poison so virulent that a few drops will destroy life with symptoms of drowsiness; but the second, "the concrete oil of tobacco," found in much smaller quantities—one pound of the plant yielding only two grains—is less violent in its action, and causes, instead of drowsiness, nausea and vomiting. The chief circumstances which modify the action of these powerful principles are the state of the man's health, his occupation, whether he drinks or expectorates while smoking, the quality and quantity of the tobacco, and lastly the method of using it. As a general rule a clean porous pipe is the most harmless, and cigarettes the most injurious mode of smoking. Both nicotine and nicotianine leave the system in the saliva, inducing the smoker to expectorate frequently, and it is to the great waste of

* Cross ventilation, which consists of admitting a current of fresh air by the opening of opposite doors and windows, is the most effectual method of reviving the atmosphere of a room. People strongly object to stale food and drink: they should be taught to object also to the breathing of stale air.

this digestive fluid that the evil effects of tobacco upon the digestion and the nutrition can be traced. Tobacco promotes a fuller excretion of sweat, and tinges the complexion with a sallow colour: it likewise profoundly affects the muscular tissue, lessening the production of energy, and rendering the contractions of the heart feeble and intermittent. In small quantities it soothes, or but slightly stimulates, the nervous system, inducing, at the most, a pleasant drowsiness; when, however, the habit is indulged in to excess, wakefulness, excitement, muscular trembling, loss of nerve control, diminished vigour, and, in extreme cases, insanity result. The following authenticated communications to the "Lancet" newspaper best illustrate how variable is the action of the plant upon individuals. Of ninety-six pensioners in Greenwich Hospital, over the age of eighty, almost all were smokers; and fourteen years' observation of our naval seamen showed an average daily consumption of one and a half ounces of tobacco, and but two instances of illness due to the habit. Among individuals, Hobbes the philosopher was one of the greatest smokers, his allowance being nineteen pipefuls each day, and he lived to be ninety. On the other hand, the Indians of North America state that the hunter who smokes gives out soonest in the chase; again, the free use of tobacco is a common cause of death among the young men who live in the tobacco-growing districts of the Southern States. Miners of the North of England and squatters of Australia are heavy smokers; both classes of men suffer from derangement of the digestive organs, disturbed action of the heart, mental depression, blindness and paralysis. To quote isolated cases: it is on record that a delicate man of twenty-five had a fainting fit, which was nearly fatal, after indulging in one cigar; that another found the consumption of six cigars during the

day to cause nervous excitement and trembling; while a third, whose daily allowance was a dozen, suffered from a temporary attack of impotence. From the above, one may fairly conclude that some people may smoke with impunity from one to four ounces of tobacco in the twenty-four hours, but other less-favoured men must not venture upon a twentieth part of that amount. On the whole, putting idiosyncrasy on one side, tobacco used in moderation undoubtedly has a salutary effect upon the health, for it allays over-excitation of the nerves, and deadens the sensations of hunger and fatigue. The most suitable time and place to smoke is after meals and in the open air; those who can best withstand its injurious effects are men of sanguine and plethoric temperaments, leading active lives; and those least able to are men who, following a sedentary occupation, are dyspeptic and feeble.

When during the preparation for athletic sports a man shows profound disturbance of health, there has usually been a grave error in the arrangement of his food or his exercise, and, in most cases, the trainer should procure assistance from the proper quarter. Slight derangement of the vital functions and other minor troubles are, however, inseparable from exposure and muscular exertion; the cause of which is often plainly apparent, and the remedy not far to seek. Exhaustion, out of proportion to the work done and attended with loss of colour, is one of these. It quickly disappears if animal food be given more freely, and such stimulant as malt liquor or burgundy added to the meal. If, with the above exhaustion, there is a sensible loss of weight, beef-tea, champagne and port wine should be given as well. In obstinate cases the work must be stopped for a few days, and change to a bracing sea-side air sought.

Remedies during training.

Even in vigorous men, temporary exhaustion and

failure of the appetite may come on after prolonged and severe exercise. The meal should then be postponed and the system, meanwhile, supported by one of the following combinations of food and alcohol : they are equally of service when, as in a final heat, a repetition of the exertion takes place within one to two hours.

1. Stir thoroughly two wine-glassfuls of sherry in half a pint of boiling milk, strain through muslin, sweeten to the taste and drink when cool.

2. Beat up an egg in a claret-glassful of sherry, and add to the mixture the same amount of boiling water.

3. Add half a wine-glassful of brandy or whiskey to a teacupful of milk, and flavour with sugar and nutmeg.

4. Beat up with two teaspoonfuls of brandy and a claret-glassful of milk the yelk of one egg, and add to the whole the whipped white.

5. Mix half a wine-glassful of brandy with two teaspoonfuls of Brand's essence of beef, and add to the mixture half a pint of water.

Excessive thirst during the day and a coated tongue, with unpleasant taste in the mouth on rising, are minor ailments. The first is best relieved by lemon-squash, or lemonade made from the fruit ; and the second by taking a tablespoonful of lime-juice twice a day, between meals, for a week. Constipation or diarrhœa occasionally results from the altered conditions of life. A most useful remedy for the former is a tumblerful of cold water in the early morning, and the substitution of brown bread for white. If this does not succeed, German liquorice powder, Hunyadi or Frederichshall water are the most suitable aperients. The relaxation of the bowels generally yields to the following :—half a small teaspoonful each of bicarbonate of soda and carbonate of bismuth beaten up in a wine-glassful of sweetened water, and taken three or four times a day, half an hour before food. Exposure to the

sun and the wind greatly inflames at times the skin of the hands, arms and face. The affected part should be bathed with milk, or with a lotion of weak Goulard water. The feet often become tender either from undue perspiration or from excessive walking: they should be bathed at night in hot soap and water, dried and then rubbed with ointment containing belladonna (if they perspire too freely) or tannin.

APPENDIX.

TABLE OF EXERCISE, LEISURE, AND SLEEP.

Summer.

Rise at 6.—Cold bath. Gentle exercise for half an hour.
Breakfast at 7.
Severe exercise from 8.30 to 11. Tepid, shower or warm bath.
Luncheon at 12.
Dinner at 4.
Moderate exercise from 6 to 8.
Light Supper at 8.30.
Bed at 10.30.

Winter.

Rise at 7.—Tepid or cold bath. Gentle exercise for half an hour.
Breakfast at 8.
Severe exercise from 9.30 to 12.30. Tepid or warm bath.
Luncheon at 1.
Moderate exercise 3 to 5.
Dinner at 6.
Bed at 10.30.

In Spring the hours should approach those of the Summer table, and in the Autumn those of the Winter one.

ANALYSIS.

	Summer.	Winter.
Sleep	$7\frac{1}{2}$ hours	$8\frac{1}{2}$ hours.
Exercise	5 "	$5\frac{1}{2}$ "
Leisure...	$11\frac{1}{2}$ "	10 "
	24 "	24 "

TABLE OF MEALS.

After bath on rising drink half a pint cold or warm milk, or weak tea and milk, with biscuit or bread and butter.

Breakfast.—Coffee, tea, cocoa, or chocolate. Milk and sugar. Bacon. Eggs. Fish or poultry. Bread (toasted or plain). Butter. Oatmeal porridge. Watercress. Lettuce. Marmalade or jam.

Luncheon.—Meat or poultry. Potatoes. Green vegetables. Bread or biscuit. Butter and cheese. Malt liquor or water.

Dinner.—Soup or fish. Meat. Game or poultry. Vegetables and salad. Blanc-mange. Light or milk puddings. Bread or biscuits. Cheese and butter. Fruit (raw or stewed). Cream. Malt liquors or wine. Coffee or tea (one or two hours after dinner).

Supper (in summer).—Sandwiches. Oatmeal porridge or boiled barley. Milk or light pudding. Biscuit and cheese. Cocoa or chocolate. Water.

TABLE OF DIET.*

(24 HOURS.)

1. Albuminous—		
Butchers' meat, poultry, game or fish (boneless and eooked)	8 oz.	
Cheese (any kind)	2 „	
Eggs	4 „	14 oz.
2. Oleaginous—		
Baeon (eooked)	4 oz.	
Butter or eream	2 „	6 oz.
3. Saeeharine—		
Bread, biseuits and flour	18 oz.	
Riee, tapioea, sago, eornflour, oatmeal (uneooked)	2 „	
Potatoes, 8 oz.; fresh vegetables, 8 oz. (uneooked)	16 „	
Sugar, marmalade or jam	2 „	38 oz.
4. Minerals and eondiments—		
Tea, eoffee, eoeoa, ehoeolate, pepper, mustard, salt		2 oz.
		60 oz.

The above yields about 25 ounees of water free food, 380 grains of nitrogen, and 5,000 grains of earbon. In addition, milk, 1 to 2 pints; beer, ale or stout, 1 pint; or spirit, 2 ounees; or wine, ½ pint; aerated water and fruit may be taken. Water should be drunk without stint.

TABLE OF THE DIGESTIBILITY OF FOOD.

Artieles of food digested in from 1 to 2 hours—

Boiled riee, sago, arrowroot, tapioea and barley, tripe, ehieken, lamb and pigs' feet, eowheel, milk, and trout. Broiled venison. Raw eggs and apples.

Artieles digested from 2 to 3 hours—

Boiled beans, parsnip, skate, pereh, sole and haddoek. Roast lamb, sueking pig, beef, turkey, goose, wild duek, partridge, and pheasant. Frieassed ehieken. Young piekled pork. Hash. Cream or new toasted eheese. Baeon, eggs lightly boiled and omelettes. Baked and roasted potatoes. Oysters, periwinkles and raw milk.

* This table must only be regarded as an approximate one.

TABLE OF THE DIGESTIBILITY OF FOOD, *contd.*

Articles digested from 3 to 4 hours—

Boiled vegetables (new and waxy potatoes, carrots, cabbage, beetroot). Beef, veal, fowls and rabbit. Turbot. Roast mutton, veal and fowls. Soups and broths. Rump steak. Bread and butter.

Articles digested from 4 to 5 hours or more—

Fish, such as salmon, herrings, mackerel, sprats, smelts, pilchards, lobsters, crabs, shrimps and prawns, whether boiled, fried, smoked, dried, salted or pickled. Roast pork, hare, heart, pigeons. Hard-boiled eggs, old cheese, caviare, kidneys.

TABLE FOR THE CALCULATION OF DIETS.

(*From "Parkes' Manual of Hygiene."*)

100 Parts of Food Material.

	Water.	Albuminates.	Fats.	Carbohydrates.	Salts.
Lean Beefsteaks ...	74·4	20·5	3·5	—	1·6
Uncooked Lean Meat	75·	15·	8·4	—	1·6
Do. Fat Meat ...	63·3	14·	19·0	—	3·7
Roast Meat	54·	27·6	15·45	—	2·95
Corned Beef... ...	40·	40·	15·	—	5·
Dried Bacon... ...	15·	8·8	73·3	—	2·9
Salt Beef	49·1	29·6	·2	—	21·1
Salt Pork	44·1	26·1	7·	—	22·8
Fat Pork	39·	9·8	48·9	—	2·3
White Fish	78·	18·1	2·9	—	1·
Poultry	74·	21·	3·8	—	1·2
Cheese	36·8	33·5	24·3	—	5·4
Eggs (10% deducted for Shell) ...	73·5	13·5	11·6	—	1·4
Milk, S.G. 1029 ...	86·8	4·	3·7	4·8	·7
Cream...	66·	2·7	26·7	2·8	1·8
Butter	6·	·3	91·	—	2·7
Bread (white wheat)	40·	8.	1·5	49·2	1·3
Flour (wheat) ...	15·	11·	2·	70·3	1·7
Biscuit	8·	15·6	1·3	73·4	1·7
Oatmeal	15·	12·6	5·6	63·8	3·
Rice	10·	5·	·8	83·7	·5
Arrowroot	15·4	·8	—	83·5	·3
Maize (cellulose excluded)	13·5	10·	6·7	64·5	1·4
Millet (ditto) ...	12·3	11·3	3·6	67·3	2·3
Peas, dry (ditto) ...	15·	22	2·	53·	2·4
Potatoes (ditto) ...	74·	2	·16	21·	1·
Carrots (ditto) ...	85·	1·6	·25	8·4	1·
Cabbage (ditto) ...	91·	1·8	·5	5·8	·7
Sugar	3·	—	—	96·5	·5

TABLE OF THE COMPOSITION OF ONE OUNCE OF FOOD.

(*From "Parkes' Manual of Hygiene."*)

	Water (in grains).	Nitrogen (in grains).	Carbon oxidizable (grains).	Hydrogen oxidizable (grains).	Sulphur oxidizable (grains).	Salts (grains).
Uncooked Beef ...	326	14·4	55	4·4	1·6	7
Uncooked Fat Beef	276	9·6	94	10·9	1·1	16
Cooked Meat ...	236	19·	110	11·	2·2	13
Corned Beef ...	175	27·6	135	12·4	3·2	21
Dried Bacon...	66	6·1	265	36·8	·7	12
Salt Beef..	215	20·4	63	3·9	2·4	92
Salt Pork..	193	18·	79	6·8	2·1	100
Fat Pork..	170	6·8	185	24·8	·8	10
White Fish ...	341	12·5	48	3·7	1·5	4
Poultry ...	324	14·5	57	4·5	1·7	5
Cheese ...	161	23·2	153	16·	2·7	24
Eggs ...	322	9.3	68	7·4	1·1	4
Milk ...	380	2·75	30	2·3	·3	3
Cream ...	289	1·9	100	13·	·2	8
Butter ...	26	·2	312	43·7	—	12
Bread ...	175	5·5	116	1·7	·6	5
Wheat Flour...	66	7·6	166	2·4	·9	7
Biscuits...	35	10·8	180	2·6	1·3	7
Oatmeal ..	66	8·7	168	4·8	1·1	13
Rice ...	44	3·5	175	3·3	·4	2
Maize ...	59	7·	169	1·4	·8	6
Millet ...	54	7·8	166	2·5	·9	10
Arrowroot	57	·5	162	—	—	—
Peas, dry..	66	15·2	156	3·9	1·7	10
Potatoes...	324	1·4	45	·4	·2	4
Carrots ...	372	1·1	20	·4	·1	4
Cabbage...	398	1·2	17	·5	·1	3
Sugar ...	13	—	178	—	—	2

TABLE OF ENERGY.

(Developed by one ounce of food material in natural state, and also deprived of water, when oxidized within the body. Calculated in foot tons. *From* PARKES.)

	With Water.	Water Free.
Beef Steak	48·5 foot tons	199 foot tons.
Fat Beef	96· "	280 "
Cooked Meat	106·2 "	240 "
Corned Beef	124· "	217 "

TABLE OF ENERGY, *contd.*

	With Water.	Water Free.
Dried Bacon	292·3 foot tons	346 foot tons.
Salt Beef	52· "	138 "
Salt Pork	71·6 "	166 "
Fat Pork	202· "	336 "
White Fish...	44·3 "	209 "
Poultry	50· "	204 "
Cheese	149·9 "	245 "
Eggs...	67·3 "	265 "
Milk...	26·9 "	225 "
Cream	109·2 "	365 "
Butter	344·5 "	367 "
Bread	87·5 "	147 "
Wheat Flour	123·6 "	146 "
Biscuits	173·3 "	189 "
Oatmeal	130· "	154 "
Rice	126·5 "	141 "
Maize	130· "	160 "
Millet	125·9 "	149 "
Arrowroot	116· "	138 "
Peas (dry)	118·9 "	151 "
Potatoes	33· "	141 "
Carrots	14·3 "	137 "
Cabbage	13· "	158 "
Sugar	126 4 "	128 "
Ale (Bass')	30· "	260 "
Stout (Guinness') ...	41·5 "	360 "

TABLE OF STRENGTH OF WINE, SPIRITS AND MALT LIQUOR.

(Percentage of Proof Spirit by volume in 100 parts, according to Christison's experiments in 1838.)

Port	...Weak	30·5
	Medium ...	34·
	Strong ...	37·25
Sherry	...Weak	30·8
	Medium ...	33·6
	Strong ...	35·
Madeira	...Medium ...	30·8
	Strong ...	37·
Claret	..."premier cru" ...	16·9
	a Château wine ...	17·0
	Vin Ordinaire ...	16·7
Hock	...Inferior	15·2
	Better	18·4
Ale	...Cask	12·6
	2 years in bottle	13·4
Beer	...Bottled	11·9

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